ENVIRONMENTAL ASSESSMENT

Rhode Island South Coast
Habitat and Community Resiliency Project
Phase I: Ninigret Salt Marsh Restoration

Ninigret Pond, Charlestown, RI

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This Environmental Assessment becomes a Federal document when evaluated and signed by the responsible Federal Official.

26 October 2016
Date

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1. Introduction

This Environmental Assessment (EA) addresses environmental impacts associated with the South Coast Habitat and Community Resiliency Project (Project) on Ninigret Pond in Charlestown, Rhode Island. The Project was funded with Hurricane Sandy funds awarded to the Department of the Interior (DOI), through the Disaster Relief Appropriations Act of 2013 and administered by the National Fish and Wildlife Foundation through the Hurricane Sandy Coastal Resiliency Competitive Grant Program. The grant program was designed to support projects that reduce communities' vulnerability to the growing risks from coastal storms, sea level rise (SLR), flooding, erosion and associated threats by strengthening natural ecosystems that also benefit fish and wildlife (NFWF 2013). The Project was selected for funding because it demonstrated the potential to protect and enhance resiliency of natural systems and help to mitigate the impacts of future storms and other naturally occurring events on communities, fish and wildlife.

In addition to the U.S. Fish and Wildlife Service (Service), the Project Team includes the Rhode Island Coastal Resources Management Council (CRMC), the Rhode Island Department of Environmental Management (RIDEM), the Towns of Charlestown and Westerly, the Salt Ponds Coalition, and Save the Bay. The Service is acting as lead Federal agency for the Project. This EA is being prepared pursuant to the National Environmental Policy Act of 1969 (P.L. 91-190; 42 U.S.C. 4321, et seq.) to evaluate existing conditions and assess potential environmental impacts of the alternatives considered for the proposed project.

1.1 Background

Salt marshes are coastal wetlands that exist at the interface of the land and the sea and are one of the most productive ecosystem habitats. Salt marshes provide nursery grounds and foraging habitat for hundreds of species of fish, shellfish, birds, and mammals, act as natural filters to remove pollutants before they reach coastal waters, and provide a natural buffer for coastal communities during storms and flooding (University of Rhode Island 2015). Research by the United States Environmental Protection Agency (EPA) and others has identified the vulnerability of coastal marshes in Rhode Island. Watson (2014) reports that substantial losses of salt marsh vegetation occurred between the 1970s and today through a combination of shoreline and channel erosion and the formation of vegetation dieback areas. Bromberg and Bertness (2005) estimated that Rhode Island has lost approximately 53 percent or 4,000 acres of salt marsh over the past two centuries due to human alteration. The observation that higher loss rates are consistent with lower elevation marshes also points to increased inundation related to rising sea level as a driver of marsh loss (Watson 2014). Watson et al. (2014) concluded that there is substantial evidence that Northeastern United States salt marshes are vulnerable to the effects of accelerated SLR, which may be exacerbated by precipitation changes or nutrient enrichment associated with cultural eutrophication.

As described by Ekberg et al. (2014), salt marshes have historically been able to increase in elevation by building up sediment and organic matter at a rate comparable to SLR (Redfield 1972). Work by Raposa et al. cited in Ekberg et al. (2014) indicates that marshes in Rhode Island are increasing in elevation at a rate of 1 to 2 mm/yr. In comparison, the long-term rate of SLR at the Newport, Rhode Island tide gauge averaged over the 84-year period from 1930 to 2013 is 2.74 mm/year, and the monthly mean National Oceanic and Atmospheric Administration (NOAA) tides data from 1993 through 2014 for both the Newport and Providence, Rhode Island tide gauge stations show SLR trends over this more recent period of about 4 mm/yr. This net increase in SLR can lead to increased inundation and loss of marsh vegetation (Donnelly and Bertness 2001).

Salt marshes across the country have been experiencing inundation, vegetation dieback, and loss of valuable salt marsh vegetation and habitat due to combinations of SLR, marsh subsidence and other external stressors. In Rhode Island, it is projected that without intervention focused on increasing salt marsh resiliency, a significant percentage of the State's existing salt marshes could be lost over the coming decades. Resource managers have identified a need to explore restoration techniques that can potentially help salt marshes become more resilient to increased rates of SLR.

In order to restore the high marsh species and regenerate lost habitat, the South Coast Habitat and Community Resiliency Project proposes using thin layer sediment deposition (TLD) to raise the elevation of the salt marsh in designated areas to reach a target elevation suitable for marsh vegetation, marsh obligate nesting birds and other key sensitive species. The overarching goals of the proposed project are to enhance marsh and ecosystem health, regenerate habitat diversity within the marsh complex and create a habitat that is more resilient to future SLR and high-intensity storm events.

Thin Layer Sediment Deposition (TLD)

TLD is an innovative salt marsh restoration technique that has only been implemented in a few locations across the country to date (e.g., Rafferty et al. 2011; DNREC 2013; Ray 2007). The process involves spreading natural sediments across sections of a salt marsh that are experiencing inundation and vegetation dieback due to rising sea levels. By placing sediments, a new platform for vegetative growth is created at the appropriate elevation relative to the water surface elevation.

The proposed project is located on Ninigret Pond in Charlestown, Rhode Island; specifically, the proposed project that is the subject of this EA will occur on the marsh lobe extending inland from the barrier beach immediately to the west of the Charlestown Breachway (Figure 1) that is part of the South Shore Management Area owned by the RIDEM.

Figure 1: Ninigret Pond Location Map

2. Purpose and Need for the Proposed Project

The purpose of the proposed project is to restore degraded salt marsh habitat, improve marsh resiliency to climate change, develop a mosaic of habitats that exhibits adequate drainage at low tide, and increase the overall area of high marsh within the marsh complex. Ninigret Pond contains several coastal wetlands and salt marshes that provide ecosystem services, habitat, aesthetic value, recreation value, and water quality improvement and nutrient uptake processes (RIDEM 2001). Salt marshes also can absorb a significant amount of wave energy and protect coastal properties from storm events. It has been predicted that if Rhode Island were able to maintain the extent of its existing salt marshes, they would provide more than $5 billion in protection of coastal properties from damage that would otherwise occur during storm events if the marshes disappear (Costanza et al. 2008). Between 1981 and 2008, salt marsh habitat coverage in Rhode Island decreased by 14 percent (Nightingale 2014) and over the past 200 years an estimated 53 percent of salt marsh in Rhode Island has been lost (Bromberg and Bertness 2005). Due to the increased rate of SLR, it is expected that this loss rate will only increase. The Sea Level Affecting Marshes Model (SLAMM) predicts a loss of 1,895 acres of Rhode Island salt marshes if sea level rises 3 feet (Rhode Island Sea Grant 2015). See Appendix A for the SLAMM maps showing the current condition and 1-, 3-, and 5-foot SLR scenario maps for Ninigret Pond.

Ninigret Pond has historically supported a complex of estuarine habitats (e.g., high and low tidal marsh, pools, and mud flats) and a variety of benthic, aquatic and terrestrial species. The need for the proposed project is driven by the fact that a significant portion of the Pond's salt marsh has been degraded or converted to open water due in part to SLR and increased flooding (Watson et al. 2014; Raposa et al. 2015; Raposa et al. 2016). This has resulted in a loss of habitat as well as other functions and ecosystem services such as nutrient uptake and water quality improvement and protection from coastal storms.

The need for the proposed project is demonstrated by the degradation of vegetation and subsidence of marsh habitat that have been documented in the proposed project area as part of the state-wide Rhode Island Salt Marsh Assessment (Ferguson 2014) The back barrier salt marsh complex is exhibiting signs of degraded marsh condition including:

- increased inundated vegetation "die-off zones" where shallow ponded areas have replaced both low and high marsh vegetation communities;
- mosquito-breeding habitat in the shallow impounded water;
- decreased width of the high marsh along the upland edge of the marsh;
- expanded areas of barren peat; and
- degraded marsh vegetation with stunted growth patterns (Ferguson, presentation, 2014).

Vegetation that is more salt tolerant and typically found in low marsh is now being observed in the former high marsh areas, which are experiencing more frequent and long-term inundation (Rhode Island Sea Grant 2014). Several sensitive species, including salt marsh sparrows, rely heavily on the high marsh habitat and are at risk due to the loss of their niche environment (Nightingale 2014). Based on current predictions for SLR, the rate of loss of salt marsh is expected to accelerate (see SLAMM Maps in Appendix A).

RI South Coast Habitat Restoration Project EA

The U.S. Army Corps of Engineers prepared an EA and Finding of No Significant Impact (FONSI) for the Rhode Island South Coastal Habitat Restoration Project which includes the dredging of the sediments in the Charlestown Breachway (ACOE 2002). Based on information presented in the EA, the FONSI concluded that there would be no significant adverse effect upon existing water quality at the dredging areas, that the project would not affect any federally or State-threatened, endangered, or rare species because of the timing of dredging and the avoidance of intertidal habitats within the marshland, and that impacts to biological resources will be minimized by not allowing dredging to occur during peak shellfish spawning seasons.

Additionally, as a result of coordination with the State Historic Preservation Office, it has been determined that no cultural resources will be impacted by the proposed dredging. The Narragansett Indian Tribe was also consulted regarding impacts to cultural resources. Table 1 summarizes the relationship between actions in the 2002 EA and the Proposed Action assessed in this document.

The sediment source for the TLD project will be two previously permitted sedimentation basins and a relief channel adjacent to the project area, which were originally designed to protect restored eelgrass beds from sedimentation. The proposed project meets the goals of the 2014 Hurricane Sandy Coastal Resiliency Competitive Grants Program funding the project, including:

- implementing an innovative restoration solution to most efficiently and effectively provide a sustainable restoration solution;
- improving coastal community resiliency by using environmentally sound techniques to restore, protect, and maintain existing wildlife resources;
- restoring native vegetation and plant communities and key plant species; and
- restoring tidal hydrology.

It should be noted that the dredging of the sedimentation basins has already been reviewed under a separate EA (see box above). That document assessed the potential environmental effects of several projects, including dredging of sediment in the Charlestown Breachway to support restoration and protection of eelgrass habitat and determined that no significant impact would occur from the dredging (ACOE 2002). The Town of Charlestown subsequently sought and received a 10-year maintenance dredging permit in 2013. The proposed project provides a beneficial reuse for the dredged sediment by utilizing it for this salt marsh restoration project, complementing the work that was assessed in the 2002 EA and maintenance dredging permit (CRMC Assent No. A2012-06-083, RIDEM Permit DP 12-116, USACE NAE-2011-356). It also should be noted that the actions that are the subject of this EA are connected with and complementary to the South Coast Habitat Restoration Project that was addressed in the 2002 EA. Table 1 summarizes the relationship of the actions in the 2002 EA and the actions described in Section 6 of this document.

Table 1
Summary of Activities in the South Coast Restoration Project EA (ACOE 2002) and this EA

Activity	Currently permitted and addressed in the South Coast Habitat Restoration Project EA (ACOE 2002)	Completed as part of previous South Coast Restoration Project (2002-2007)	Proposed Project (Ninigret Salt Marsh Restoration Project) (2015-16)	Potential Impacts Assessed in this EA
Action A (Section 6.3) - Dredging of Sedimentation Basins and Relief Channel	X	X	X (as sediment source)	
Action B (Section 6.3) - Placement and grading of dredged material on marsh surface (TLD)			X	X
Action C (Section 6.3) - Placement of dredged material in intertidal zone east of breachway	X	X		
Dredging of tidal shoals for eelgrass restoration	X	X		

3. Ninigret Pond

Ninigret Pond, one of the largest salt ponds in Rhode Island bordered by back barrier salt marsh and coastal shrublands, is connected to the Atlantic Ocean via the Charlestown Breachway (Figure 1). The 1,700-acre pond is 6 km long and 1.4 km wide (RIDEM 2006). Ninigret Pond connects to Green Hill Pond which is located directly to the east (Figure 1). The Pond is surrounded by residential, light commercial and protected Federal land, and three small marinas. Ninigret Pond abuts East Beach on the barrier island to the west of the Charlestown Breachway. The Charlestown Town Beach is located on the eastern side of the Charlestown Breachway. The Service's Ninigret National Wildlife Refuge borders Ninigret Pond but does not entirely surround it; see Figure 2 below for a map of the project area in relation to the Ninigret National Wildlife Refuge.

The Pond itself is designated as state waters with the project area classified by the CRMC as Type 2, Low-Intensity Use Waters. Type 2 waters are defined as waters in areas with high scenic value that support low-intensity recreational and residential uses. These waters include seasonal mooring areas where good water quality and fish and wildlife habitat are maintained. The proposed project is entirely located within State-owned property that is part of the South Shore Management Area owned by RIDEM. It should be noted that the proposed project is located on only a small percentage (approximately 15 percent) of the total estuarine wetland located within Ninigret Pond.

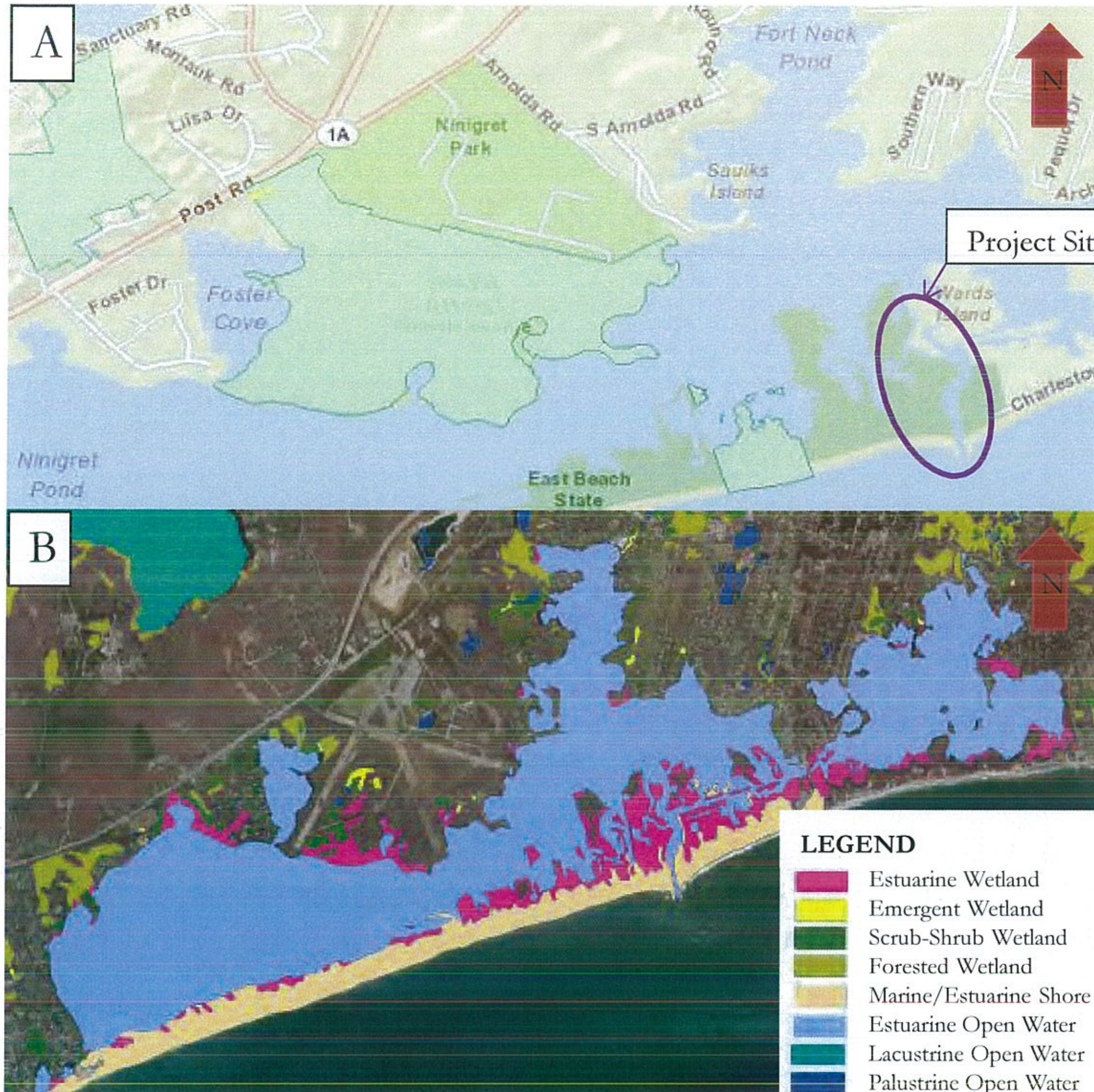

Figure 2: (A) Project Site and Ninigret National Wildlife Refuge, (B) Wetland Resource Areas at Ninigret Pond

4. Issues, Concerns, and Opportunities

The overarching issue is the observed degradation and habitat loss at the Ninigret salt marsh. The observed loss of low marsh vegetation and the conversion of high marsh vegetation communities to low marsh or open water is correlated to rising sea levels as an important driver of these changes (Raposa et al. 2015; Watson et al. 2014). As mentioned in Section 1, the rate of SLR has increased and is currently outpacing the rate of sedimentation in Rhode Island coastal marshes (see Figure 3). As a result of rising sea levels, low marsh species are colonizing traditionally high marsh areas, which are becoming inundated to the point that they can no longer support high marsh plant species. The impacts of this are multiple. High marsh plant species provide key niche habitat for several sensitive species and are therefore crucial for salt marsh diversity and ecosystem health. The loss of high marsh habitat is a trend that has been observed in marshes throughout the State through the Rhode Island Salt Marsh Assessment conducted by Save The Bay (Ekberg et al. 2014) and by sentinel site monitoring conducted by the Narragansett Bay National Estuarine Research Reserve (Raposa et al. 2015). SLR is also causing creation of inundated die-off areas which stunt vegetative growth and provide mosquito breeding habitat. Coastal erosion as a result of severe storms has caused significant economic loss for several coastal towns in Rhode Island, including Charlestown. The economic value of salt marshes related to recreational and commercial fishing activities alone is estimated to be $6,417 per acre in Rhode Island (Haas 2014).

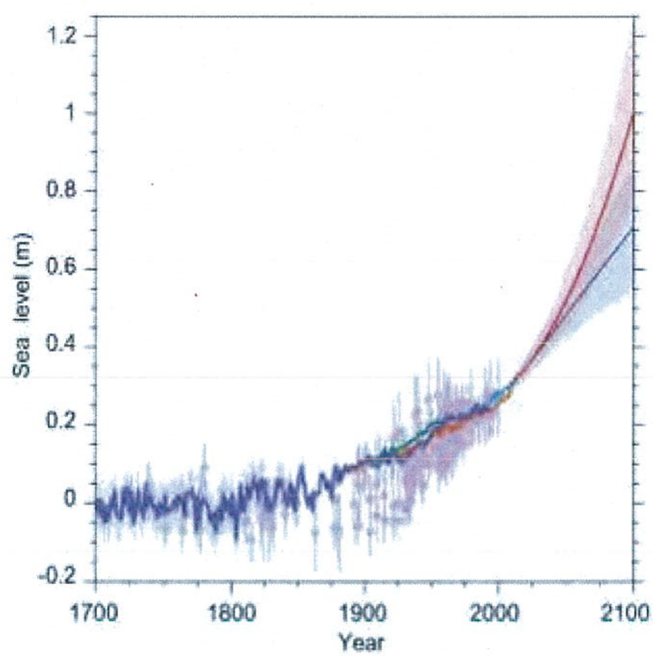

Figure 3: Historic and Projected Sea Level Rise Based on Three Emission Scenarios (NBEP 2014)

For the purposes of developing the Rhode Island South Coast Habitat and Community Resiliency Project and evaluating the proposed activities, several key issues, concerns and opportunities were considered.

Salt Marsh Habitat Restoration

The proposed project has a primary goal of restoring high marsh species and increasing the marsh's resiliency to future SLR. By raising the surface elevation of the marsh with locally sourced sediments and by providing effective drainage pathways on the restored marsh, the project aims to mimic natural overwash processes to provide a platform for natural growth and restoration, particularly of high marsh species. Because the high marsh habitat has most significantly been negatively impacted, the project will prioritize restoration of those vegetation communities in order to improve habitat diversity within the marsh complex. Targeting elevations at the upper high marsh dominated by black rush (*Juncus gerardii*) and high tide bush (*Iva frutescens*) will also help to extend the "lifespan" of the project as sea level continues to rise. Successful restoration and marsh growth will require that effective drainage on the marsh is achieved to avoid ponding and stunted vegetative growth. Grading the deposited sediments to ensure adequate drainage of the marsh surface at low tide will result in an elevation gradient that will support both high and low marsh vegetation communities. The proposed methodology is one that has been used successfully in other regions, including the Gateway Recreation Area Salt Marsh Restoration in Long Island, New York (Rafferty et al. 2011) and the Pepper Creek marsh restoration project in Dogsboro, Delaware (DNREC 2013), but not yet in New England.

Migratory Bird Habitat

In 2001, a Federal executive order (E.O. 13186) was issued requiring Federal agencies to promote conservation of migratory bird populations and provide management plans and habitat for such species (Federal Register 2001). This project will effectively improve key salt marsh habitat within the migration corridor and therefore provide key habitat and space for migratory birds within the region.

Fisheries

Ninigret Pond provides spawning, breeding and feeding habitat for several species of fish and other aquatic animals. The Pond contains a variety of in-water habitats including estuarine and shallow-water areas that are key environments for a number of species, including winter flounder (*Pseudopleuronectes americanus*), bluefish, (*Pomatomus saltatrix*), tautog (*Tautoga onitis*), black sea bass (*Centropritis striata*), scup (*Stenotomus chrysops*), Atlantic silversides (*Menidia sp.*), striped killifish (*Fundulus majalis*), common mummichog (*Fundulus heteroclitus*), and sheepshead minnow (*Cyprinodon variegatus*) (Lake 2013). It is expected that SLR, increased water temperatures, and the die-off of salt marsh vegetation has caused degradation of these key habitat features over the last several years, further decreasing productivity for marine fish in the Pond. Decreased spawning and feeding habitat can significantly negatively impact commercial and recreational fisheries. By restoring salt marsh, in-water habitat diversity is expected to increase, benefiting the fish populations. Additionally, the dredging of the previously permitted sedimentation basins and relief channel in the Charlestown Breachway is expected to protect recently restored eelgrass habitat as detailed in the Rhode Island South Coast Habitat Restoration Project EA (ACOE 2002).

Mosquito Breeding Habitat

As mentioned above, SLR and increased flooding have created inundated, hydrologically disconnected inundated "vegetation die-off zones" on the salt marsh which prevent vegetative growth. These inundated areas are mostly stagnant, warm water with mucky, often algae-covered substrate and do not provide viable habitat for salt marsh fish species, and therefore provide mosquito breeding habitat. Mosquito larvae in these areas have been observed frequently during field assessments on the marsh (Ekberg et al. 2014). Restoring these die-off areas will not only restore salt marsh habitat, but will also reduce the public health threat of mosquito-breeding habitat. Mosquitos carry harmful blood-borne diseases that can negatively affect bird and mammal populations. Due to the proximity of the salt marsh to popular recreational areas and the Charlestown Town Beach, eliminating mosquito-breeding habitat is a significant co-benefit of the project, although not an explicit focus.

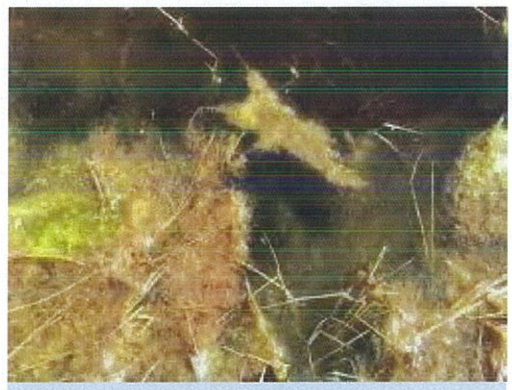

Figure 4: Mosquito Larvae on Ninigret Pond Salt Marsh

Recreational Use and Sediment Deposition

Ninigret Pond is a popular recreational area, and is used for boating, fishing, and beach access. The restoration of the salt marsh will improve the aesthetic quality of the Pond's marshes and therefore improve the recreational value and wildlife sighting opportunities in the Pond. Excess dredged sediment that is not used for thin layer deposition will be discharged in the intertidal zone located to the east of the breachway to maintain and restore the recreational value of the eroded beach as well as improve each habitat for shorebirds.

5. Affected Environment

The proposed project area consists of approximately 37 acres of low and high marsh vegetative communities as well as areas of open water tidal creeks, scrub-shrub habitat and pools (Figure 5), as well as a maintenance dredging area within the Charlestown Breachway channel. The potential environmental effects of the salt marsh restoration activities are the focus of this EA. The potential environmental effects of dredging of the sedimentation basins and relief channel to supply the material for TLD have already been assessed in the 2002 Rhode Island South Coast Habitat Restoration Project EA, which resulted in a FONSI by the sponsoring agency, the U.S. Army Corps of Engineers. In addition, a 10-year permit for maintenance dredging of the sedimentation basins was issued to the Town of Charlestown in 2013. Permit modifications are being submitted to include the use of the dredged material for thin layer sediment deposition on the adjacent marsh with any excess material not being used for restoration placed on State-owned property within the intertidal zone below the mean high tide to the east of the Charlestown Breachway. The original plan for disposal also called for placement adjacent to the Charlestown Town Beach located immediately to the east of the Charlestown Breachway, so this was included in the 2002 EA.

The 37-acre area of the proposed project is on a lobe of the marsh that is located immediately to the west of the Charlestown Breachway, inland of the beach. Within this area, TLD is proposed on six priority deposition areas that total approximately 22 acres. The priority areas that were identified for thin layer sediment deposition by the Project Team are shown in Figure 5 as Areas A through F. Priority areas were selected based on Real Time Kinematic (RTK) elevation measurements (Figure 9), current level of habitat degradation (areas of stressed vegetation, areas of shallow impounded water, etc.), accessibility, the size of the site, and existing vegetation type. It should be noted that these areas are priority areas for the proposed target elevations, but that sediment deposition may be required outside of these areas to grade each area to drain and to tie into adjacent elevations. Restoration efforts will be focused within the areas shown. However, no work will extend outside of the 37-acre salt marsh lobe area and no TLD work will be done within the existing sandy bottomed channels, creeks, or historic pools within the marsh that are currently providing fish habitat, with the exception of temporary crossings that will be installed during the sediment placement activities in order to traverse the tidal creeks to reach each restoration area. The temporary crossings will consist of marine sediments, the same dredged material that is to be placed on the marsh. Upon completion of restoration on the opposite side of the creeks, the material will be removed and the creeks will be immediately restored to their previous condition.

The text below describes the priority restoration areas and basis for selection. Work to be performed in these areas is described in Section 7.2 of this EA.

Area A

The target habitat for this restoration project is high marsh, consisting primarily of saltmeadow cordgrass (*Spartina patens*), black rush, and spike grass (*Distichlis spicata*), which is found at an elevation between approximately 6 to 12 inches (North American Vertical Datum of 1988 [NAVD88]), and high tide bush, which tends to grow at an elevation above 8 inches (NAVD88). Area A is almost entirely below an elevation of 4 inches (NAVD88), and has almost no area above 6 inches (NAVD88). Through the addition of sediment, the elevation of this area can be raised to support the desired high marsh species, providing added resiliency for future SLR. Additionally, its location on the eastern side of the marsh allows for easy access for the placement of dredged sediment from the channel.

Area B

Like Area A, Area B is almost entirely below an elevation of 4 inches (NAVD88), and has almost no area above 6 inches (NAVD88). Through the addition of sediment, the elevation of this area can be raised to support the desired high marsh species, providing added resiliency for future SLR. Although the central tidal creek separates this area from the location of the main dredge operations, material can be delivered to Area B through the temporary filling of the creek to create an access bridge. With the temporary bridge in place, its proximity to the eastern side of the marsh will allow for easy access for the placement of dredged sediment from the channel.

Area C

Area C has small pools of open water that are shallow, with mucky sediments, disconnected from the main open water channels and do not support fish. Increasing the surface elevation in this area would promote the reestablishment of high and low marsh species, which would not only provide habitat and feeding grounds for EFH species at high tides in the near future, but as SLR continues. As sea levels continue to rise and the restored high marsh areas transition back to low marsh, this area will provide important future fish habitat as well. Although this area is the farthest away from the dredge area, careful planning and selection of a sediment stockpile area, potentially in conjunction with the stockpile location for Area B, will allow this to be a feasible restoration area.

Essential Fish Habitat (EFH)

Essential Fish Habitat is defined by the Magnuson-Stevens Fishery Conservation and Management Act, Public Law 94-265 as "those waters and substrate necessary to fish for spawning, breeding or growth to maturity" (Public Law 1996).

Figure 5: Priority Restoration Areas on Ninigret Pond Salt Marsh

Area D

Area D has large areas of impounded water that are shallow, with mucky sediments, disconnected from the main open water channels and do not support fish. Increasing the surface elevation in this area would promote the reestablishment of high and low marsh species, which would not only provide habitat and feeding grounds for EFH species at high tides in the near future, but will provide important future fish habitat as SLR continues and the restored high marsh areas transition back to low marsh in the future. Due to their proximity with each other, as well as to the channel to be dredged, a single sediment stockpile area would likely suffice to restore Areas D, E, and F.

Figure 6: *Juncus* Growth and Die-Off in Area D

Area E

This area has large sections of dieback areas and shallow, impounded water with mucky sediments covered in filamentous algae mats that are disconnected from the main creeks and do not support fish. Increasing the surface elevation in this area would promote the reestablishment of high and low marsh species, which would not only provide habitat and feeding grounds for EFH species at high tides in the near future, but as SLR continues, the restored high marsh areas will transition back to low marsh, providing important future fish habitat as well. Due to their proximity with each other, as well as to the channel to be dredged, a single sediment stockpile area would likely suffice to restore Areas D, E, and F.

Figure 7: Shallow Impounded Area in July 2013
(Photo from Save The Bay)

Area F

This area consists predominantly of a section of salt marsh that has been disconnected from Area E by an overwash from the breachway. Water remains trapped on the marsh surface and the lack of circulation or connection to tides has prevented fish from accessing the marsh. These degraded marsh conditions have allowed the proliferation of mosquito breeding as evidenced by high concentrations of larvae within the pool. The goal for this site is primarily to raise the elevation of the area, and eliminate the impoundment of water that is promoting mosquito growth. Due to their proximity with each other, as well as to the channel to be dredged, a single sediment stockpile area would likely suffice to restore Areas D, E, and F.

5.1 Collected Data and Observations

An RTK elevation survey of the marsh was completed by the Town of Charlestown in November 2014. Elevation data were reported to be collected in inches relative to NAVD88 and are presented in Figure 9. This figure shows that while there are some higher areas around the margins of the marsh, the majority of the marsh platform is below an elevation of 6 inches (NAVD88), with much of it below 4 inches (NAVD88).

Figure 8: *Juncus, Spartina patens, Solidago,* and *Iva* Growing in the Higher Elevations of the Overwash Area in Area F (Photo from Save The Bay)

The 2014 elevation survey included classifications of vegetation type at a few spots within the marsh. In addition, plant species information was collected along 11 transects during the Fuss & O'Neill April 2015 survey. During both efforts, vegetation was classified as "bare," "short-form *Spartina alterniflora* [smooth cordgrass]" "*Spartina alterniflora*," "transition (high and low marsh plants growing together," "*Spartina patens*," "*Juncus gerardii*," "Phragmites [common reed]," "creek" or "marsh deep" (signifying open water). By correlating these vegetation types to their elevations, average elevations for each vegetation type were determined. A Technical Memorandum (Woods Hole Group and Fuss & O'Neill 2015) summarizing the existing conditions onsite based on the current assessment is available upon request. This memorandum also describes the recommended proposed project based on the current assessment. The existing conditions from the memorandum are summarized below.

Many of the lower elevation areas have transitioned from healthy salt marsh vegetation to sections of stunted and/or stressed smooth cordgrass or to entirely bare areas in recent years. Furthermore, given the SLR predictions for this area (see discussion below), the marsh vegetation within these areas of low elevation will be further stressed and become even less likely to support a healthy salt marsh community. Representative photographs of dominant vegetative communities are provided in Attachment A of the Technical Memorandum (Woods Hole Group and Fuss & O'Neill 2015). By extracting the elevation/vegetation points from the 2014 and 2015 surveys, elevation ranges were determined for respective vegetative community types, as depicted in Figure 10 below. As seen in this figure, within areas near Elevation 4 inches (NAVD88), low marsh species such as smooth cordgrass dominate, and at lower elevations this species becomes stunted or is no longer able to survive. It should be noted that saltmeadow cordgrass was observed in the overwash area with elevations higher than Elevation 12 inches (see Figure 6); however, it is not expected that the target vegetation species, such as saltmeadow cordgrass, would remain dominant at elevations higher than Elevation 12 inches, and might be easily taken over by phragmites or other undesirable species in that area.

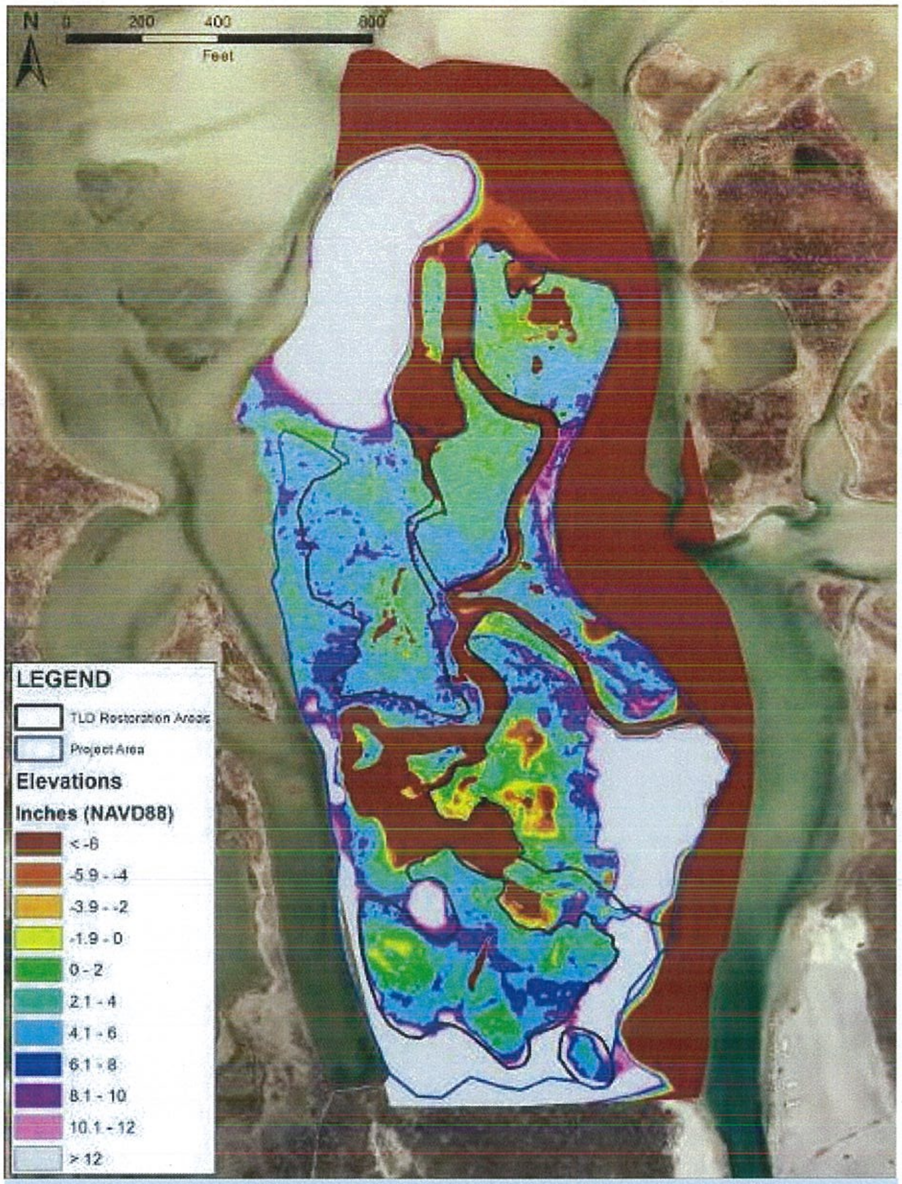

Figure 9: RTK Elevation Data (Note: areas shown in white exceed elevation 12″ NAVD88)

In addition to assessing the restoration area's salt marsh elevations, plant communities, and tidal channels/pools, a number of sediment cores were conducted to evaluate sediment strata. One sediment core was collected from each of the 11 sample transects used for the 2015 vegetation survey. Each core was measured and characterized by sediment type and color. Three representative cores (designated "Area C Sed-01," "Area D Sed-03," and "Area E Sed-01" in field data reports) were separated into two samples (one composite sample from the upper organic layer and one composite sample from the lower mineral layer) and transmitted for physical laboratory analyses. In each core, the upper fibric sediment layer can be clearly distinguished from the gleyed mineral sandy layer of the core. A summary of measurements and classifications for each of the sediment layers observed at the three cores is presented in Table 2 below.

5.2 Salt Marsh Habitat

Vegetative communities within the project area consist of high marsh, low marsh, and upland habitats. High marsh communities within the project area predominantly consist of saltmeadow cordgrass, spike grass, black rush, high tide bush, and common reed. Saltmeadow cordgrass and spike grass are often found above the mean high tide line in areas that flood twice a month. Black rush and high tide bush occupy the highest elevations of the salt marsh. Common reed generally occurs in the areas where high marsh transitions to upland habitat. Low marsh communities within the project area predominantly consist of smooth cordgrass with glasswort (*Salicornia spp.*) observed in a few areas (Woods Hole Group and Fuss & O'Neill 2015). Smooth cordgrass is typically found below the mean high tide line in areas that flood daily (NRCS 2002). Certain areas of the site intermixed with smooth cordgrass and black rush have been observed, indicating a shift in habitat from high marsh to one dominated by more flood-tolerant plant species.

Vegetation dieback is evident in various low and high marsh areas of the salt marsh (Woods Hole Group and Fuss & O'Neill 2015). Those dieback areas have a combination of shallow impounded water, stunted vegetation or exposed peat, and are often covered with mats of filamentous algae during the growing season. Stunted smooth cordgrass was often found around the perimeter of the dieback areas in the low marsh during an April 2015 field visit by Fuss & O'Neill, Inc., indicating progressive expansion of these areas of degradation. The dieback areas are distinctively different from the salt pannes, or pools, on the site. The pools on the site are deeper depressions usually a foot or more in depth that generally have defined banks and are surrounded by healthy vegetation. Pannes, sometimes formed by the deposition of wrack on the marsh platform, typically do not contain standing water at low tide and are often colonized by forb species if located in the high marsh. Some of the dieback areas are rather large (approximately 1 acre in area) and give a clear indication of the magnitude of habitat loss due to degradation. During Fuss & O'Neill's April 2015 site visit, marine species (i.e., hermit crabs and common periwinkles) were observed in the healthy pools and tidal creeks, various species of birds (i.e., great and snowy egrets) were observed foraging in the pools and tidal creeks and small pannes, and mammals (i.e., mink and meadow vole) were observed utilizing the healthy vegetated communities. Wildlife was not observed utilizing the vegetation dieback areas.

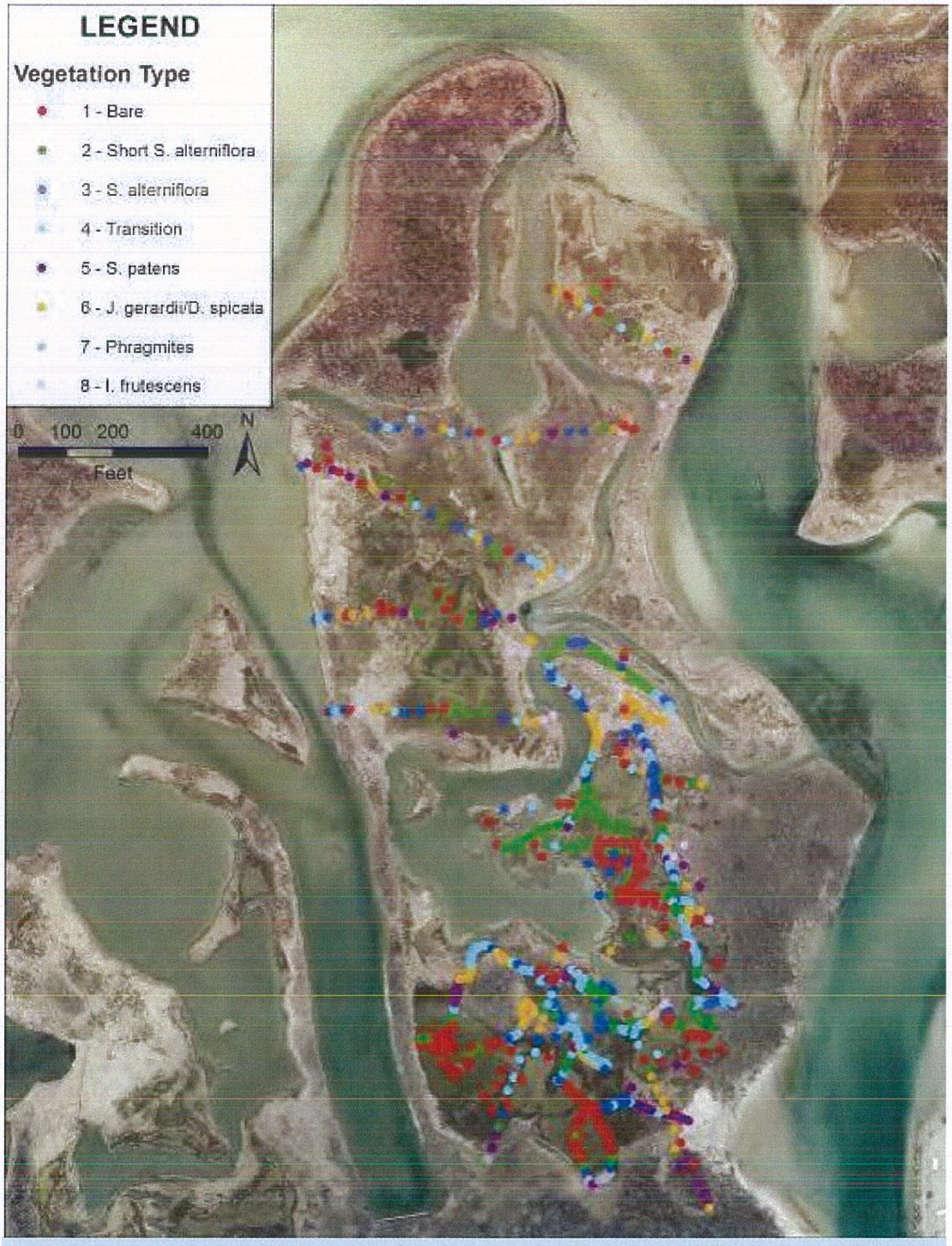

Figure 10a: Vegetation Data

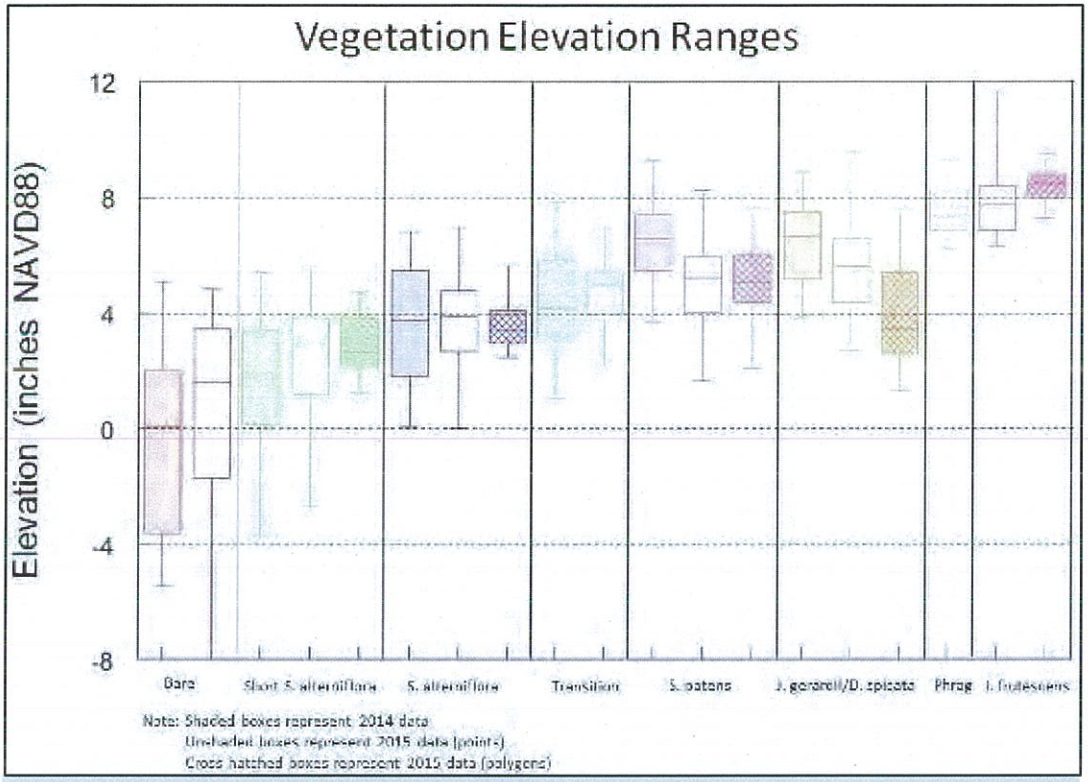

Figure 10b: Corresponding Elevation Ranges

Table 2
Summary of Observed Sediment Core Strata

Area C Sed-01		Area D Sed-03		Area E Sed-01	
0" – 15"	Fibric/Peat	0" – 6"	Fibric/Peat	0" – 6"	Fibric/Peat
15" – 30+"	Sand GLEY 5/10Y	6" – 24"	Sand GLEY 5/N	6" – 15"	Humic sand GLEY 5/10Y
				15" – 24"	Sand GLEY 5/10Y

Note: Depths indicated are distances below ground surface at core location.

5.3 Marine Fish and Essential Fish Habitat

Fish species known or presumed to inhabit the salt marsh habitat within the proposed restoration areas on the site include Atlantic silverside (*Menidia menidia*), striped killifish (*Fundulus majalis*), mummichog (*Fundulus heteroclitus*), fourspine stickleback (*Apeltes quadracus*), sheepshead minnow (*Cyprinodon variegatus*), rainwater killifish (*Lucania parva*), white mullet (*Mugil curema*), threespine stickleback (*Gasterosteus aculeatus*), bluefish (*Pomatomus saltatrix*), Atlantic menhaden (*Brevoortia tyrannus*), and striped bass (*Morone saxatilis*). It is likely that additional fish species would move in and out of the tidal creeks and pools on the site, especially at high tide, given its proximity to the breachway. Species that would potentially utilize those on-site areas, but not the proposed restoration areas, include smooth dogfish (*Mustelus canis*), winter flounder (*Pseudopleuronectes americanus*), tautog (*Tautoga onitis*), black sea bass (*Centropristis striata*), Atlantic herring (*Clupea harengus*), northern pipefish (*Syngnathus fuscus*), grubby (*Myoxocephalus aenaeus*), striped sea robin (*Prionotus evolans*), American eel (*Anguilla rostrata*), Atlantic needlefish (*Strongylura marina*), alewife (*Alosa pseudoharengus*), pollock (*Pollachius virens*), smallmouth flounder (*Etropus microstomus*), cunner (*Tautogolabrus adspersus*), northern kingfish (*Menticirrhus saxatilis*), and inshore lizardfish (*Synodus foetens*). (J. Lake, personal communication, May 12, 2015)

Ninigret Pond is considered EFH, as defined by NOAA, for smooth dogfish. Smooth dogfish are known to utilize shallow shoal and tidal marsh creek habitats. Young-of-the-year use estuaries as nurseries from late spring through the fall. They enter tidal marsh creek habitats with the night tides to forage on small crustaceans and fish (Weisberg and Lotrich 1982), making this habitat, like those areas within the project site, critical nursery areas for smooth dogfish. (Rountree and Able 1996) Open water tidal creeks and pools within the marsh are shown in Figure 11.

Killifish, also known as common mummichog, is another species that is known to utilize the tidal creeks and channels within the salt marsh habitat for spawning. Mummichogs spawn during the highest spring tides, depositing their eggs in the higher portions of the marsh to ensure incubation in locations away from strong tidal currents (Taylor et al. 1979). Mummichogs also utilize the tides for foraging in salt marshes. Studies have shown that mummichogs enter the vegetated areas of the salt marsh during the daytime flood tide with an empty stomach and return to deeper waters during the ebb tide with a full stomach (Weisberg et al. 1981).

The tidal creeks and pools within the project area have sandy bottoms and are hydrologically connected to the larger channel within the marsh, unlike the areas targeted for sediment placement which are hydrologically isolated areas with mucky bottoms and thick algal mats. Winter flounder are known to utilize tidal creeks and pools for spawning; however, historically, most of the winter flounder spawning in Ninigret Pond has taken place in Foster Cove and Kenyon Cove (Salt Ponds Coalition, personal communication, 2015). They typically return to their natal waters to spawn during the winter and spring months in shallow, inshore waters, laying their eggs on sandy bottoms and algal mats. Winter flounder larvae and some juveniles live in the estuarine habitat in which they were born.

Figure 11: Tidal Creeks and Pools within the Project Area

Figure 12: Open Water Pool in Area E in May 2015 (Photo from Save The Bay)

5.4 Wildlife Resources

Ninigret Pond is home to various species of wildlife that utilize the salt pond and salt marsh habitat during some point in their lifetime. Rhode Island has identified "Species of Greatest Conservation Need" for birds, invertebrates, mammals, herptofauna, and fish in the 2015 Rhode Island State Wildlife Action Plan (RIDEM 2015). These species are not necessarily federally or State-listed species (some of which are also present at the site, as noted below), but rather are on this list due to their limited habitat range and risk of habitat loss due to such factors as climate change and SLR. An additional resource for bird species potentially utilizing the project site includes the Ninigret Pond and Conservation Areas Important Bird Area (National Audubon Society 2013), and the Atlantic Coast Joint Venture New England/Mid-Atlantic Coast Bird Conservation Region 30 implementation plan (Service 2008). The following is a description of the species that are known to be found in the project area.

5.4.1 Birds

Numerous species of birds use the salt marsh habitat on the project area for breeding, nesting, feeding, and staging during migration. Of the bird species identified in the Rhode Island State Wildlife Action Plan and the Bird Conservation Region 30 Plan, the following is a list of the birds considered most likely to be observed within the project area. The piping plover, roseate tern and red knot, all federally listed species, are discussed in more detail in Section 5.4.5.

Salt marsh obligate species known or presumed to utilize the project site include the saltmarsh sparrow (*Ammodramus caudacutus*), seaside sparrow (*Ammodramus maritimus*), and willet (*Tringa semipalmata*). Saltmarsh sparrows nest in high marsh habitat and forage in low marsh habitat, and thus are considered among the highest conservation priority species in the region. According to surveys conducted during the breeding season by Walter Berry (USEPA 2014), saltmarsh sparrows and seaside sparrows were observed in the marshes adjacent to East Beach and in the marshes in the vicinity of the Charlestown Breachway.

Tidal creeks, channels, and pools on the project site are utilized by various piscivorous species, including the great egret (*Ardea alba*), snowy egret (*Egretta thula*), glossy ibis (*Plegadis falcinellus*), herring gull (*Larus argentatus*), yellow-crowned night heron (*Nyctanassa violacea*), black-crowned night heron (*Nycticorax nycticorax*), common tern (*Sterna hirundo*), least tern (*Sternula antillarum*) and roseate tern (*Sterna dougallii*), for foraging and staging during migration.

The following species utilize intertidal mud flats for foraging and stopover during the spring and fall migration. These include the least sandpiper (*Calidris minutilla*), sanderling (*Calidris alba*), semipalmated plover (*Charadrius semipalmatus*), short-billed dowitcher (*Limnodromus griseus*), black-bellied plover (*Pluvialis squatarola*), and greater yellowlegs (*Tringa melanoleuca*). The tidal creeks within the project area provide high-quality habitat for these species. These species are not known to utilize the vegetated marsh habitat within the restoration areas.

The snowy owl (*Bubo scandiacus*) is a species known to utilize the project site intermittently during the non-breeding season and was observed at the project site this past winter (2015). Evidence of its presence at the site was observed during a field visit in April 2015. Also observed during that site visit was the presence of nesting Canada geese (*Branta canadensis*).

5.4.2 Invertebrates

Marine invertebrate species known or presumed to inhabit the project area include the common periwinkle (*Littorina littorea*), long-clawed hermit crab (*Pagurus longicarpus*), green crab (*Carcinus maenus*), ribbed mussel (*Geukensia demissa*), marsh fiddler crab (*Uca pugilator*), blue crab (*Callinectes sapidus*), and horseshoe crab (*Limulus polyphemus*).

5.4.3 Mammals

Mammals potentially present in salt marshes such as the project area include meadow vole (*Microtus pennsylvanicus*), mink (*Neovison vison*), raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*), chipmunk (*Tamias striatus*), white-tailed deer (*Odocoileus virginianus*), and coyote (*Canis latrans*). Meadow vole and mink were observed on the project site during a field visit in April 2015. These species are common in Rhode Island and are not obligate salt marsh species (Center for Ecosystem Restoration 2015).

5.4.4 Amphibians and Reptiles

Amphibians would not be expected to inhabit this salt marsh environment, given their permeable skin's sensitivity to salt water. The reptile species that has the most potential to be present is the northern diamondback terrapin (*Malaclemys terrapin*), though its presence in the project area has not been observed in recent years. This is an estuarine turtle known to utilize Rhode Island's south shore and historically has been observed in the coastal ponds (ACOE 2002). A study conducted in 2013 surveyed and documented potential and confirmed sites in Rhode Island for the diamondback terrapin. Ninigret Pond was among the research sites visited during this study, but diamondback terrapin presence was not observed in Ninigret Pond (Schwartz 2013).

5.4.5 Threatened and Endangered Species

The intertidal habitats of the Ninigret coastal pond could potentially support three federally and State- listed species, the endangered roseate tern (*Sterna dougallii*), the threatened piping plover (*Charadrius melodus*) (Paton and Trocki 1999; ACOE 2002) and the threatened red knot (*Calidris canutus rufa*). Both the roseate tern and piping plover primarily utilize the coastal ponds from April 1 through August 31 (Service 1994). Red knot has not been observed in the coastal ponds, but has been recorded on barrier beaches in the State in small numbers during primarily the fall migration extending through October.

The roseate tern is a species of concern due to its limited population size and recent declines. Roseate terns nest on offshore islands and have been observed staging in the project area before fall migration. If observed on the project site, these species would be found in the tidal creeks, channels and pools and among the mud flats. The terns feed over the subtidal portions of the shoal areas within the ponds and rest upon the intertidal portions of the shoals; they would not be expected to utilize the vegetated marsh habitats.

The piping plover is among the most common beach nesting birds present on the barrier beach habitat south of the project site during the summer months. Piping plovers nest on coastal sandy beaches adjacent to tidewater and forage in the intertidal zone and on mud flats. This species is federally listed as threatened in the Northeast region and is one of the most intensively monitored birds in the region (Service 2015, 1). Although this species may utilize the mud flats and sandy shoals on the project site for foraging, they are not expected to utilize the vegetated marsh habitat within the proposed restoration areas. Piping plovers are not in Rhode Island during the non-breeding season when this project will occur.

The rufa red knot feeds on small clams and mussels found along coastal beaches and intertidal flats during migration to and from their arctic breeding areas. This species is not expected to utilize tidal marsh habitats, but could potentially be found on intertidal mudflats during fall migration extending into approximately mid-October.

The proposed project is located within the range of the federally threatened northern long-eared bat (*Myotis septentrionalis*) (NLEB). In the summer, these bats roost, forage, and raise pups in mixed stands of trees of greater than 3 inches diameter breast height that have cracks, cavities, or loose bark. The project is located entirely within areas of open water (sub-tidal and intertidal), emergent tidal wetland, and intertidal beach. During the winter months, NLEB congregate at hibernacula and there are no known hibernacula near the project site. Given the lack of trees in the project area, and the timing of the project, NLEB are not expected to occur within the project areas.

5.5 Public Use and Recreation

Ninigret Pond is heavily used for recreation in the summer months. Recreational activities occurring on the Pond include sport and commercial fishing and shellfishing, boating, wind surfing, and birding. Boating within the Pond is limited to small boats due to the shoals and narrow channel connecting the Pond to the Charlestown Breachway. Shellfishing within the Pond is currently limited to the western portion of the Pond due to water quality impairments in the eastern portion of the Pond (see Section 5.6 below) (RIDEM 2006). The Pond also provides a valuable educational and aesthetic resource for the community.

5.6 Water Quality

Ninigret Pond is classified as a "Class SA" waterbody under the Rhode Island Water Quality Regulations, meaning it is designated for "shellfish harvesting, direct human consumption, primary and secondary contact recreation activities and fish and wildlife habitat" (RIDEM 2006). Class SA waters must meet fecal coliform bacteria standards for shellfishing criteria and for primary contact

Total Maximum Daily Load (TMDL) Analysis for Green Hill Pond, Ninigret Pond, Factory Pond Stream and Teal Pond Stream; South Kingstown and Charlestown, Rhode Island

This TMDL addresses fecal coliform impairments to several waterbodies in the area, including the eastern portion of Ninigret Pond. The TMDL locates potential pollutant sources and outlines implementation strategies to abate pollution sources.

recreational/swimming criteria. Shellfishing criteria (which are more stringent criteria) require non-exceedance of a geometric mean value for all samples of 14 MPN (most probable number)/100ml fecal coliform and not more than 10 percent of samples exceeding a value of 49 MPN/100ml (RIDEM 2009). Due to the connection with Green Hill Pond, which has a significant fecal coliform pollutant issue, the easternmost portion of Ninigret Pond has impaired water quality based on fecal coliform sampling results that exceed the State standards (RIDEM 2006). The total maximum daily load (TMDL) developed for this portion of the Pond (see box) identifies septic systems, stormwater and waterfowl as potential sources of bacteria within the watershed contributing to Ninigret Pond and prescribes point source stormwater management, septic system performance improvements and control of nonpoint source loadings within the watershed to meet the TMDL goals (RIDEM 2006).

A 2013 review of the aquatic health of Ninigret Pond based on dissolved oxygen saturation, chlorophyll-a abundance, water transparency and nitrogen abundance, determined that the overall health of the waterbody ranged from fair to good at the five monitoring stations measured (Callender and Torello 2014). The areas with the lowest overall aquatic health were located in the western portions of the waterbody (Callender and Torello 2014).

Poor water quality, particularly elevated nitrate-nitrogen concentrations, can further contribute to and exacerbate salt marsh degradation and loss (Watson 2014). Poor water quality can act as a stressor to healthy marshes, but can inflict a greater negative impact on marshes already experiencing degradation.

5.7 Tidal Flows

Tidal flushing drives the hydrologic dynamics within the Pond. Tidal flow into and out of the Pond is restricted by the Charlestown Breachway that separates East Beach and the Charlestown Town Beach. As ebb and flood tides enter the Pond, water velocities decrease, dropping sediment out of suspension from the water column. This has caused the buildup of sediment in the Charlestown Breachway channel and on the tidal deltas and restored eelgrass areas to the north of the breachway. The Town's maintenance dredging program allows for removal of sediment from established sedimentation basins within the breachway channel to prevent sedimentation and smothering of the restored eelgrass beds. Tidal elevation data was monitored by the Town of Charlestown (Woods Hole Group and Fuss & O'Neill 2015).

5.8 Sediment History and Handling

The Town of Charlestown holds a 10-year maintenance dredging permit that expires on March 26, 2023, which allows for maintenance dredging of two defined sedimentation basins and a relief channel in Ninigret Pond with beneficial reuse of the material. Dredging of these basins is necessary and required by the U.S. Army Corps of Engineers to maintain restored eelgrass beds established as part of the South Coast Habitat Restoration Project completed in 2007 and 2012. Historically, the Town has used the dredged material to supplement eroded sections of the Charlestown Town Beach; however, this project will use the permitted basins as sources of sediment to complete the goals of the marsh restoration project. Any excess dredged material will be used to supplement the Charlestown Town Beach located to the east of the Charlestown Breachway.

In January 2001, sediment sampling of the eelgrass restoration areas and sedimentation basin in Ninigret Pond was conducted. Sediments were analyzed for grain size and water content. Additional data on sediment composition and sedimentation rates were collected in May of 1999 as part of a survey of the sedimentation rates of the Pond. Seven sediment samples from the Ninigret Pond shoals and sedimentation basin areas (to a depth of 8.4 feet in the sedimentation basins) revealed that the majority of the substrate was composed of predominantly sand material (<12 percent fines). Grain size data from the sedimentation rate study (for cores to a depth of 20 cm) also revealed that the shoals were composed of sandy material (ACOE 2002). Sedimentation rates (as studied in a 1999 survey) were found to be approximately 1.1 cm per year (ACOE 2002). However, based on the current rate of deposition, the Town has determined that the channel needs to be dredged approximately every 4 years.

As mentioned above, sediment coring on the marsh was completed in 2015. The sediment cores found that in general there was very little peat (2"-12") atop sandy deposits.

Figure 13: Example Sediment Core Profile from Ninigret Salt Marsh

5.9 Cultural Resources

The project area is not listed on the National Register of Historic Places, nor is it part of a National Register District. The Service consulted with both the Rhode Island Historic Preservation & Heritage Commission (HPHC) and the Narragansett Indian Tribe Tribal Historic Preservation Officer (THPO) under section 106 of the National Historic Preservation Act to determine the potential for the presence of other cultural resources on the site (Appendix D). Potential for impact to cultural resources in the proposed project is primarily associated with ground-disturbing activities, i.e., dredging. Prior assessment of cultural resources in the areas of proposed dredging is documented in the 2002 EA for the Rhode Island South Coast Habitat Restoration Project and resulted in a Programmatic Agreement between the U.S. Army Corps of Engineers New England District, the CRMC, and the Narragansett Indian Tribe (Appendix D). The Rhode Island HPHC, in a letter dated July 2, 2015, concluded that they had no objection to the proposed project as the project will have no effect on above- or below-ground resources (Appendix D). The THPO called with specific questions about the project that were addressed in a follow up letter dated August 7, 2015 (Appendix D).

6. Alternatives Considered

Two alternatives for the proposed project were considered: 1) take no action, and 2) complete a TLD deposition project to restore estuarine and salt marsh habitat. Under the No Action alternative (Alternative 1 in this EA), the Town would proceed with the existing maintenance dredging and beneficial reuse program, using the dredged material to supplement eroded areas of the Charlestown Town Beach, when funding becomes available and implementation is feasible. Alternative 1 would not use the awarded DOI Federal funds to complete the already permitted dredging work. Alternative 2 involves using the dredged sediment from the approved sedimentation basins and relief channel to complete the estuarine and salt marsh habitat restoration project using TLD. The awarded DOI Federal funding would be used for both dredging and TLD under the Preferred Alternative (Alternative 2 in this EA). Federal funds would not be used for dredging in the absence of salt marsh restoration, since that would not be consistent with the grant objectives. Each alternative is described in detail below.

6.1 Factors Common to Both Alternatives

Dredging of the sedimentation basins and relief channel would occur under both alternatives (see locations of sedimentation basins in Figure 14 below). The Town of Charlestown holds the necessary permits for maintenance dredging of the primary and secondary sedimentation basins and relief channel and placement of the dredged material in the intertidal area adjacent to Charlestown Town Beach, on the eastern side of the breachway entrance. If the South Coast Habitat and Community Resiliency project did not occur, this dredging would occur when sufficient funds had been raised by the state and Town of Charlestown. If the marsh restoration project does occur, the basins and relief channel would be used as a source of sediment for the marsh restoration, and the awarded DOI funding would be used to cover the costs of the maintenance dredging, allowing it to occur during the upcoming 2015-2016 dredge season.

Potential environmental effects of the dredging were considered in the 2002 South Coast Restoration Project EA and 401 Water Quality Certification prepared by the U.S. Army Corps of Engineers (ACOE 2002).The Service is utilizing the findings of the 2002 EA for the purposes of this project. The 2002 EA discussed the environmental consequences of dredging in the Charlestown Breachway within the context of a project to restore approximately 40 acres of eelgrass habitat within the tidal shoal areas at the entrance to the Pond (see Figure 15). The EA determined that except for some minor short-term negative effects, the project will have positive effects on the environment. The minor negative impacts identified in the 2002 EA would be common to both alternatives discussed in this EA and include:

- temporary impacts to water quality and suspension feeders (including shellfish) from slight increases in turbidity during dredging;
- destruction of immobile benthic organisms in the direct footprint of construction activities; and
- temporary impacts to recreational access to dredging and disposal areas.

The EA concluded that the primary cumulative impact was "the positive impact of improving the habitat quality of Rhode Island's coastal and pond ecosystems. Habitat restoration coupled with improved water quality would foster numerous ecological benefits such as increases in prime fish and shellfish habitat, as well as provide an additional primary production source to the ecosystem" (ACOE 2002). In addition, a maintenance dredging permit was issued to the Town in 2012 for the primary and secondary sedimentation basins and relief channel to prevent further sedimentation of the restored eelgrass bed areas.

6.2 Alternative 1: No Action

Under the No Action alternative, no direct action will be made to restore the salt marsh habitat. It is likely that dredging of the sedimentation basins and relief channel will not occur in the 2015-2016 dredging period, but will be delayed, pending funding (the awarded DOI funding will not be used for the dredging in the absence of reuse for marsh restoration). The No Action alternative does not meet the Purpose and Need for the project as described in Section 2. Under the No Action alternative, dredging may not occur for several years which could lead to further degradation of the estuarine environment, including additional sedimentation in the restored eelgrass areas and potential degradation of the eelgrass habitat.

Figure 14: Charlestown Breachway Channel Dredging Basins and Volumes

In addition, if marsh surface elevations in the project area are not increased, it is likely that there will be a continued loss of salt marsh habitat as more areas become permanently inundated with rising sea levels and vegetation die-off (see SLAMM maps for projected SLR impacts in Appendix A). The result would be an increase in open water and intertidal mud flat habitat and a loss of scarcer high marsh habitat. The degradation and disintegration of the marsh and marsh substrate could also lead to increased turbidity within the existing tidal creeks and pools from suspended sediments and the release of excess nutrients into the system.

It has been shown that salt marsh peats have high concentrations of nutrients (Portnoy and Giblin 1997), and that decomposition of marsh peat, and subsequent nutrient release, could stimulate primary productivity in the water column (Portnoy 1999). An isotopic study of marshes including the Narrow River, Quonochontaug Pond and Gooseneck Cove algae conducted by Save the Bay showed that algae present on the degraded marsh surface seemed to be deriving nutrients from the decomposing salt marsh peat. It follows then that the algal blooms observed in the impounded water areas on the Ninigret salt marsh could be incorporating nutrients from smooth cordgrass sedimentary material.

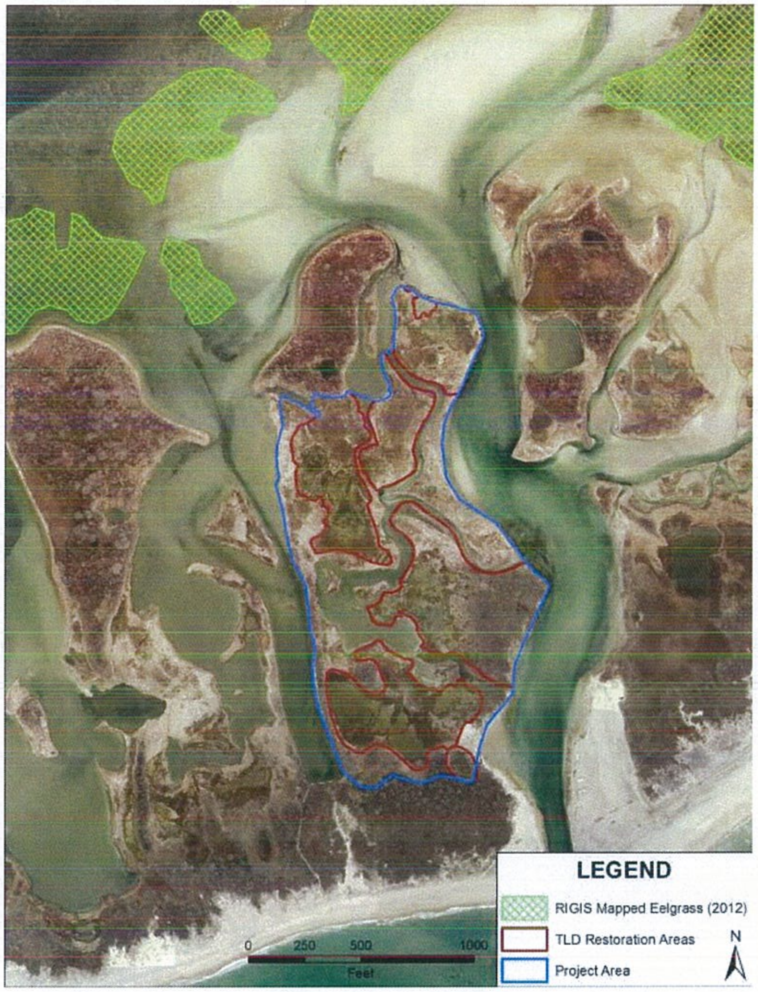

Figure 15: Eelgrass Beds Adjacent to Project Site

The 2002 EA noted that without dredging, "the existing eelgrass and associated shellfish, plant and animal communities will experience various rates of decline until the shoal and associated environmental conditions achieve some equilibrium. Eelgrass growth models for Ninigret [Pond] predict that if the no action alternative is selected, eelgrass in the areas surrounding the shoals will persist for a limited time with low to moderate growth and may eventually be eliminated by sedimentation" (ACOE 2002).

6.3 Alternative 2: Preferred Alternative – TLD to Restore Estuarine and Salt Marsh Habitat

This alternative is the Preferred Alternative because it meets the Purpose and Need for the proposed project described in Section 2. Alternative 2 will allow for prompt dredging of the sedimentation basins and relief channel which will be the most protective of restored eelgrass bed areas. Alternative 2 also provides for salt marsh restoration through the use of the dredged material to increase marsh surface elevations to restore a mosaic of marsh habitat and increase the marsh's resiliency to SLR and high-intensity storm events expected in the future as a result of climate change. This alternative consists of three related actions: estuarine channel and basin restoration (Action A), restoration of salt marsh habitat (Action B), and beach nourishment (Action C).

In order to maximize future succession and establishment of high marsh plant communities and thereby increase future resiliency of this salt marsh, a primary finding of the elevation/vegetation assessment was that the restoration approach should target the high end of the elevation ranges inhabited by desired vegetative species (see Figure 10):

- elevation 7 - 10 (inches, NAVD88) for saltmarsh cordgrass, black rush, and spike grass; and
- elevation 10 - 12 (inches, NAVD88) for high tide bush.

In order to choose the optimum fill elevation to achieve the project goal, potential compaction of the existing marsh material as a result of the weight of the deposited material and potential compaction from construction activities were considered. The bulk densities of the analyzed cores are shown in Table 3.

In order to estimate the expected compaction due to placement of sand on the marsh plain, it is necessary to estimate the average weight of the sediment that will be deposited. The organic layer of the marsh surface in this project is relatively thin and the estimated thickness of the sediment placed on the marsh surface will be approximately 0.5 feet (6 inches). The weight of this material (consisting of 0.5 ft^3 of sand) over an area of 1 ft^2 of dry sand is approximately 50 lbs/ft^2. The maximum depth of sand cover on the highest areas will be approximately 1 foot. Therefore, these areas will be subjected to approximately double the weight, resulting in approximately 100 lbs/ft^2. For comparison, a person weighing 220 lbs would exert approximately 660 lbs/ft^2 on each boot as he/she walks through the marsh.

While there is no definitive method of calculating the depth of compaction, an examination of Table 3 shows that the bulk density of the organic layer varies between 69.4 and 78.9 pounds per cubic foot (pcf). Using this information, it is estimated that the compaction will vary from 10 percent of the thickness of the organic layer in the areas covered with 6 inches sediment to up to 20 percent of the thickness of the organic layer in areas covered by 12 inches of sediment. Therefore, the expected compaction in the area covered by 6 inches or less will be on the order of 0.5 inch and up to approximately 1.5 inches in the areas that are covered with 12 inches of sediment (Woods Hole Group and Fuss & O'Neill 2015).

The compaction associated with moving construction equipment over the marsh will be minimal because the construction design calls for the use of mats to run the small loaders across the marsh surface. The mats will distribute the weight of the machine, thereby reducing the possibility of compaction. Minimal compaction is expected as the result of moving the small machines across the marsh surface as long as the machines do not sit on the marsh surface for extended periods of time. Additionally, it is not expected that the dredged/deposited sediment itself will compact after placement due to the makeup of the material.

Table 3
Sediment Sample Analytical Results

Sample ID	Sample Name	% Sand*	% Fines* (Silt & Clay)	Bulk density (pcf)
699150415-01A	Area C Sed-01 organic	NA	NA	73.45
699150415-01B	Area C Sed-01 mineral	92.3%	7.6%	103.7
699150416-02A	Area D Sed-03 organic	NA	NA	69.42
699150416-02B	Area D Sed-03 mineral	86.2%	13.7%	113.7
699150416-03A	Area E Sed-01 organic	NA	NA	78.9
699150416-03B	Area E Sed-01 mineral	83.6%	16.1%	96.7

*Note: only mineral soils were analyzed for grain size

Additional design considerations including current and future tide ranges and elevations, the surface elevations of the marsh platform, potential construction impacts, and drainage conditions are discussed and described in the Technical Memorandum (Woods Hole Group and Fuss & O'Neill 2015).

To estimate the volume of material necessary to complete this design, each restoration area was divided into elevation "tiers"; the largest central portion of each area would represent a target elevation of 12 inches (NAVD88), and then subsequent outer tiers would represent lower elevations of 10 inches, 7 inches and 4 inches (NAVD88) as you move closer to the tidal creeks. Each area was divided into these elevation "tiers" for the purpose of volume calculation (Woods Hole Group and Fuss & O'Neill 2015). Areas D and E have the area to be filled to 12 inches NAVD88 extended all the way to one side due to the presence of higher elevations bordering those zones; those elevations can simply be tied into the higher elevations rather than tapering down to a lower elevation as is necessary in the vicinity of the tidal creeks. In Area E, the deposited sediment will tie into the overwash area in the southeastern part of the restoration area. Similarly, due to its small size and the higher surrounding elevations, Area F will be filled to an elevation of 12 inches across its whole area. The Technical Memorandum (Woods Hole Group and Fuss & O'Neill 2015) provides additional information about the areas and volumes necessary to complete each elevation region of each restoration area.

To account for the minor compaction that will likely occur as a result of adding sediment to the marsh plane, the overall estimate for the total volume of sediment necessary to complete the project was adjusted. Based on the above discussion, between 0.5 and 1.5 inches of compaction is likely where there is 6-12 inches of sediment placed on the marsh. Although most areas will receive less than or approximately 6 inches of material, to be conservative, an additional inch of material was added to the volume for much of the restoration area; this brings the target elevations for construction up to 5, 8 and 11 inches (NAVD88), rather than the initial plan of 4, 7, and 10 inches (NAVD88). The method described above was applied to all areas except where the target elevation is 12 inches (NAVD88).

Because compaction is expected to be minor where 6 or less inches of fill are placed on the marsh, and much of the area to be built to an elevation of 12 inches (NAVD88) will require only this amount of fill, compaction in these areas, as with the other elevation target areas, is expected to be minor. The primary difference between these zones, however, is that the areas to be restored to 12 inches (NAVD88) are already at the fringes of the elevation range within which salt marsh vegetation (including high tide bush) will grow. Overfilling these areas has the potential to turn large swaths of marsh plain into upland. Additionally, in order to accommodate future climate change conditions, the upland areas will be needed to allow for marsh migration. Therefore, in this case, it is favorable to potentially end up with elevations approximately 11.5 inches (NAVD88) due to minor compaction than to create large areas with elevations closer to 13 inches (NAVD88), which would be the result if compaction does not occur (Woods Hole Group and Fuss & O'Neill 2015). Based on this reasoning, updated target elevations and necessary volumes of fill are presented in Figure 16. To account for compaction, an additional 1,569 cubic yards of material will be needed, requiring a total of 16,078 cubic yards.

To ensure an adequate amount of material, an additional 20 percent contingency volume should be added to the stockpiles developed at the project site. This would result in a total volume of 19,294 cubic yards of sediment to be placed at the site.

In practice, although depicted as tiers of different target elevation, these zones will be graded smoothly together as part of the construction process; the creation of tiers provides a simplified way to estimate the total volume required for the project and may also serve as a useful model during the construction process.

Although the proposed restoration project aims to increase the elevation of much of the marsh platform through the placement of sediment to targeted elevations, it is important to consider tidally connected channels and pools and their importance as marine fisheries habitat. These areas will be left undisturbed and unfilled, and will continue to function as potential EFH for a number of marine and estuarine species that utilize the Ninigret Pond ecosystem.

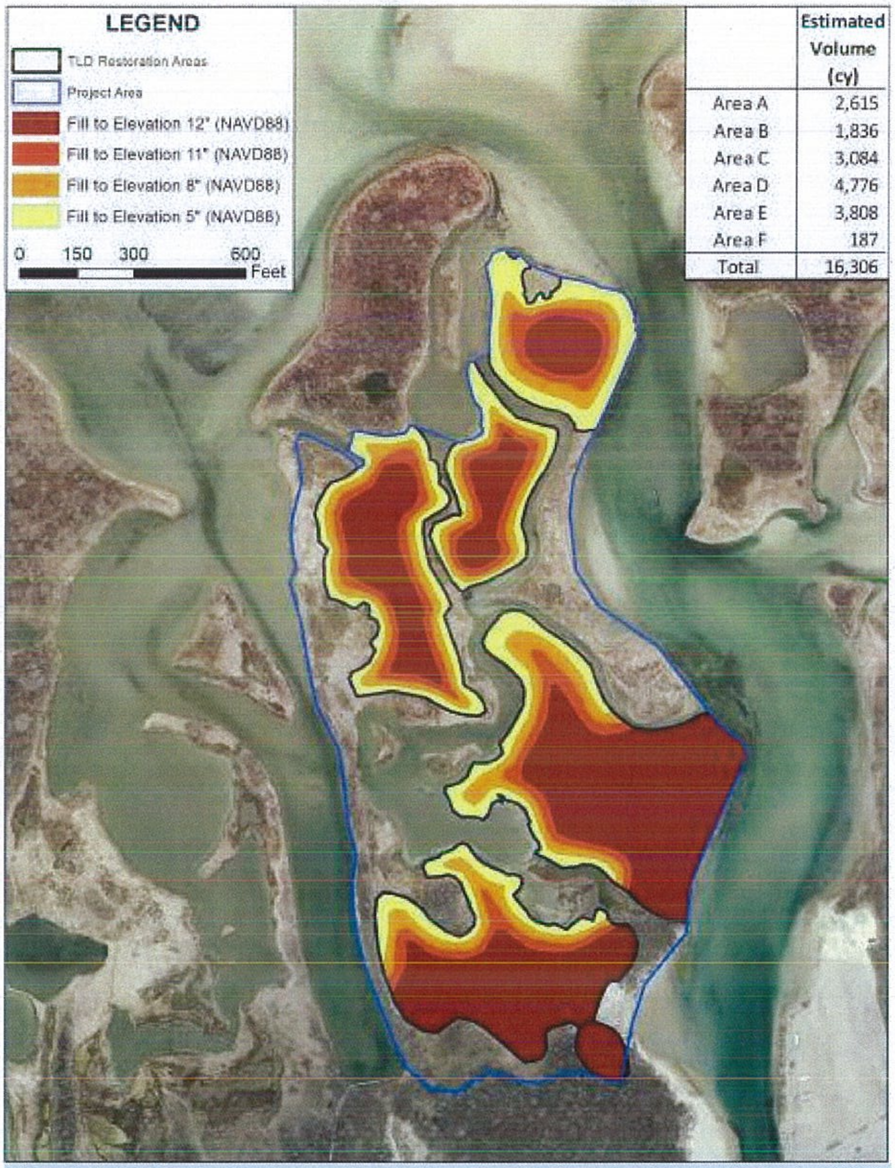

Figure 16: Estimated Fill Volumes for Targeted Marsh Restoration Areas (including adjustments for compaction)

In addition to these tidally influenced channels and pools, a number of isolated stagnant pools exist within the targeted restoration area, formed as a result of poor drainage conditions on the marsh. The restoration approach will be to fill these isolated pools and grade to targeted elevations to restore desired salt marsh communities, unless an alternative field-directed decision is made to connect one or more pools to adjacent tidally influenced channels or pools (Woods Hole Group and Fuss & O'Neill 2015).

Sediments will be discharged to the marsh area and mechanically spread on the marsh to reach the required elevations (see description of methods in Section 6.3.2 below). The placed sediments will be graded to drain to prevent ponding of stagnant fresh (from rain runoff) or saltwater pools in the marsh interior.

After the addition and grading of the fill is complete, 3 acres of live plantings are planned as part of the restoration design. In addition, there will likely be different treatments, such as seeding, additional plantings, or no planting at all in different areas, to monitor what develops and which is the best approach for the site. The project will implement additional plantings/seeding if/where needed as an adaptive approach is called for based on the planned monitoring. These areas will be identified during construction as material is placed and the team evaluates and selects different areas to try different revegetation practices. The project's monitoring plan is detailed in Section 6.4 below.

Another goal of this alternative will be to dredge the maximum amount from the sedimentation basins and relief channel, ideally to their permitted depths, to maximize the time until future maintenance dredging is needed. Once the elevation targets within all restoration areas on the marsh are reached, excess material within the sedimentation basins and relief channel will be pumped and discharged to the intertidal area on the Charlestown Town Beach, to the east of the breachway.

6.3.1 Action A: Estuarine Channel and Basin Restoration

This action involves enhancement of marine fisheries habitat by restoring sedimentation basins designed to prevent transported sediment from burying restored eelgrass beds within the Pond. The sediment dredging will be executed as outlined in the 2002 EA and in the existing 10-year dredging permit held by the Town of Charlestown. The restored basins will create a sink that will allow sand transported by longshore currents into the Pond to settle out before reaching the tidal deltas that were dredged to create over 40 acres of eelgrass habitat but are once again expanding.

The previous eelgrass bed restoration project was a $2.7 million effort led by the U.S. Army Corps of Engineers and the CRMC that is currently being threatened by sediment deposition. The sedimentation basins were dredged to act as a sediment sink that would prevent shoaling in the location of the eelgrass beds. However, the sedimentation basins are now full again, and the eelgrass beds are being threatened. If the dredging is completed this year, the efforts will be able to protect the previous efforts and restored eelgrass beds; however, if dredging is postponed, shoaling in the area of the restored beds will continue. An additional benefit of completing dredging this year is that removal of the sediment from the sedimentation basins will improve recreation access to and from the marsh for fishing, bird watching and other recreational activities. The previous EA states that "Constructing a sedimentation basin in the breachway…will (if properly maintained) substantially reduce shoaling in the ponds" (ACOE 2002). Therefore, proper maintenance (near-term dredging) of the breachway is required to ensure continued reduction of shoaling in Ninigret Pond.

6.3.2 Action B: Restore Lost High Marsh, and Build Resiliency to Sea Level Rise

This action involves restoring high marsh habitat that has been lost due to SLR, and increasing salt marsh elevations to enhance resiliency in the face of future SLR and high-intensity storm events. This will be done by beneficially reusing the dredged sediments from the breachway channel to raise the surface elevation of the marsh.

Dredging of sediment will be conducted within the dredging window established in the maintenance dredging permit (November 15 through February 15) to avoid impacts to fish breeding cycles and public access. In-marsh sediment placement activities will be completed before the end of April to minimize impacts to marsh vegetation growth and nesting avian species.

The dredged sediments will be discharged to central locations within the proposed restoration areas and mechanically spread with small or low ground pressure equipment to target elevations. Four proposed centralized discharge locations are shown in Figure 17. Multiple sediment staging areas are preferred to central stockpiling due to the reduced potential for erosion/scour, wheel rutting from increased vehicle trips across the marsh, and consolidation of native soils from the weight from stockpiling materials in a large centralized location.

The effluent dredging line will discharge sediments to two-sided dewatering basins constructed of concrete barriers. Water will discharge from the opened side opposite the discharge line. Structural weirs will be used to shift the discharge to different locations so that the material is evenly spread (not stockpiled) and weight is distributed across the deposition area (see planimetric discharge staging plan in Figure 17). Discharged sediments will be transported to the desired areas using small or low ground pressure earth-moving equipment on "swamp mats." "Swamp mats" are essentially portable access mats that interlock and provide a strong surface for heavy equipment to traverse wet and soft areas while minimizing rutting and compaction. The sediments will then be mechanically spread to the desired elevation using the same small earth-moving equipment. Target elevations will be confirmed using RTK GPS equipment, and checked throughout the sediment spreading process to ensure accurate depths of sediments to meet the project's restoration goals. Any areas impacted by dredging equipment or material discharge or placement equipment will be repaired with material placement. Any areas that are compacted or lowered below the target elevation as a result of construction will be raised to the target elevation using excess dredged material.

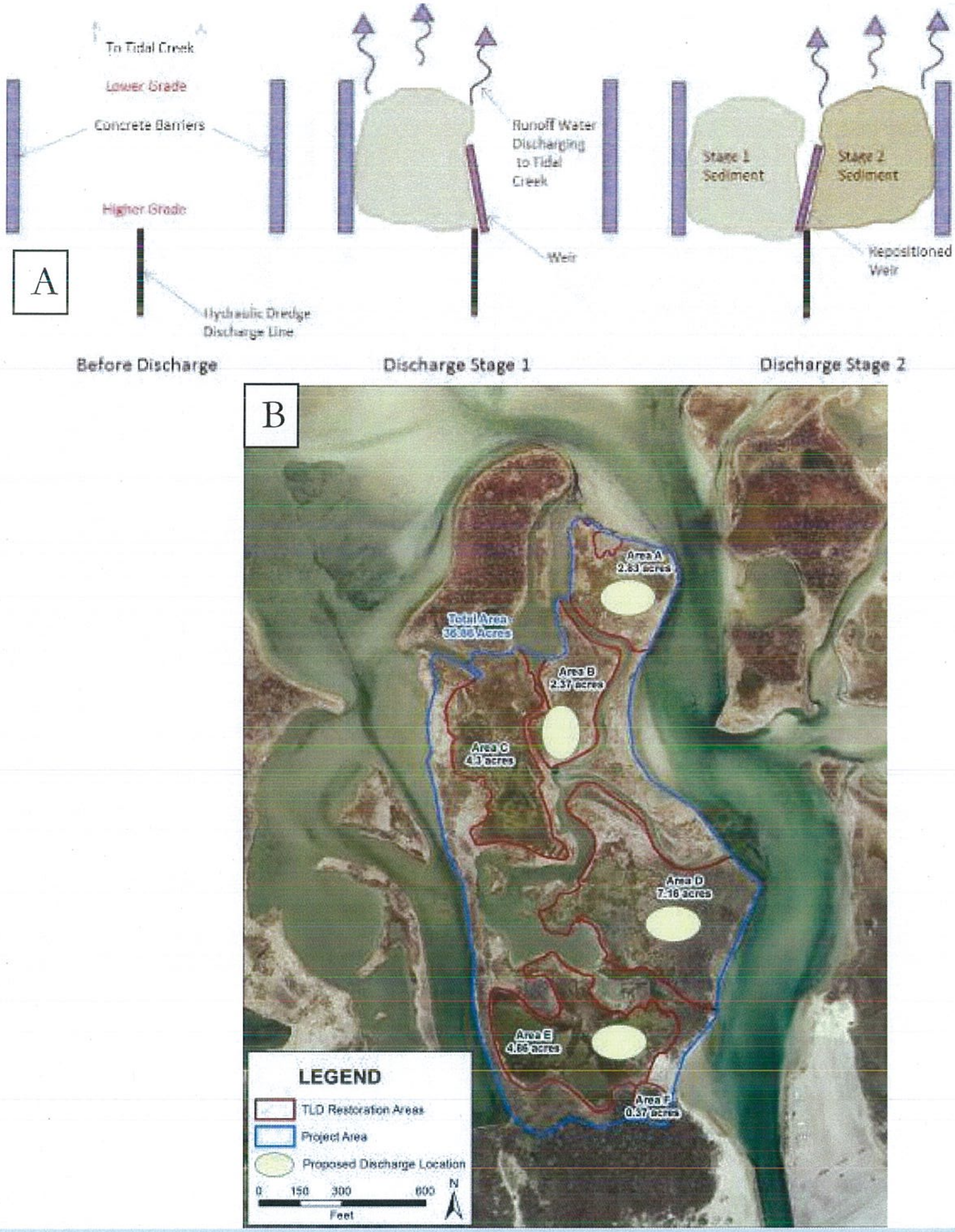

Figure 17: (A) Simplified Planimetric Discharge Staging Plan, (B) Proposed Discharge Locations

Primary goals for the marsh restoration part of the project include creation of a mosaic of marsh habitats, including restoration of high marsh areas dominated by saltmeadow cordgrass and black rush and improvement of marsh drainage by maintaining tidally connected channels and pools as part of the mosaic. In order to control turbidity throughout the project sequence, an adequate vegetated buffer will be maintained between the placed sediment and the open water tidal creeks. Existing vegetation along the limits of the tidal creeks will act as a buffer (natural sediment control) to filter water exiting the discharge areas and to reduce potential increases in turbidity in the tidal creeks as a result of TLD placement. As the dredged material will be sand, which settles quickly after suspension, transport and turbidity issues are anticipated to be minimal.

This project will serve as a pilot TLD project in the State of Rhode Island and will be used as an example for future salt marsh restoration projects. TLD has been used successfully for marsh restoration in several locations, including in Delaware Bay, DE; Chesapeake Bay, MD; and Jamaica Bay, NY (see TLD Box on page 6).

6.3.3 Action C: Placement of Dredged Material in Intertidal Zone East of Breachway

This action involves restoring the intertidal zone on the eastern side of the breachway by placing excess dredged materials in an eroded intertidal area near the mean high water line. This action will involve beneficial reuse of the dredged sediments from the breachway channel to restore intertidal beach habitat.

Placement of excess dredged material on the intertidal zone to the east of the breachway will be completed before April 1 to avoid disturbance to nesting piping plovers.

The dredged sediments will be discharged to a central location within the area to be restored in the intertidal zone. Any areas in the intertidal deposition area that are impacted as a result of construction will be leveled. As the dredged material will be sand, which settles quickly after suspension, transport and turbidity issues are anticipated to be minimal.

6.4 Monitoring

A monitoring plan (Appendix C) has been developed by the project monitoring team consisting of researchers from the Narragansett Bay National Estuarine Research Reserve, EPA Atlantic Ecology Division and Save the Bay in coordination with the Service. The plan includes elements for monitoring at an adjacent reference wetland site immediately west of the proposed restoration area. An adaptive management plan framework to guide future implementation of the monitoring plan, and potential development of a formal adaptive management plan, is being developed by Woods Hole Group for the project to assist in ensuring the project's overall goals are met. The monitoring team will feed data to the adaptive management team who will evaluate the results and provide recommendations for adaptive management actions, which may include supplemental plantings or excavation of small creeks (by small or low ground pressure equipment or by hand) to ensure adequate tidal exchange to restored marsh areas. While the goal is to grade the TLD restoration areas to drain, it is expected that some minor ponding may occur as a result of variation in settlement or other natural processes that may move the sediment after placement. Therefore it is expected that some adaptive management to ensure proper drainage will be necessary.

Elevation benchmarks placed on the proposed restoration area and reference wetland site will be used to monitor elevation changes on these marshes, with vegetation monitoring transects used to monitor the response of the salt marsh vegetation to the TLD project. Additionally, the response of bird populations to TLD on the marsh will be monitored by the University of Connecticut and the Saltmarsh Habitat and Avian Research Program (www.tidalmarshbirds.org). This program received funding to evaluate DOI-funded marsh restoration across New England and the mid-Atlantic, in addition to their established monitoring sites. They will have point count stations within the project area and at the adjacent marsh on the Ninigret National Wildlife Refuge.


Figure 18: Ninigret Pond Salt Marsh

7. Environmental Consequences

This discussion of environmental consequences focuses on the areas of potential environmental effect consistent with the purpose and intent of the National Environmental Policy Act. Several sectors of the environment are not relevant to the proposed project given its location and nature, and are therefore not included in this consideration of environmental consequences (e.g., environmental justice, wild and scenic rivers, transportation, etc.). Short-term effects associated with only the construction phase of the project are described in the construction impacts (Section 7.2.9).

7.1 Alternative 1: No Action

It should be noted that under Alternative 1, the Town will still be able to dredge the sediments from the Charlestown Breachway channel. However, it will likely not occur as immediately as under Alternative 2, which could result in further degradation of the eelgrass habitats that were restored as part of the $2.7 million South Coast Restoration Project. Restoration of the salt marsh would not occur under Alternative 1, likely leading to additional loss of salt marsh habitat.

7.1.1 Salt Marsh Habitat

Under the No Action alternative, the degradation of the salt marsh community would continue due to rising sea level as a result of climate change. Areas of ponding on the marsh interior would continue to increase, reducing the amount of remaining salt marsh habitat and increasing the die-off areas and the areas suitable for mosquito breeding habitat. Loss of valuable vegetative species only found in this specific salt marsh habitat would continue. Decreasing elevations would continue to result in the loss of high marsh habitat species, including saltmeadow cordgrass, spike grass, and black rush. Low marsh habitat consisting of smooth cordgrass would likely become the dominant vegetative community where there is currently high marsh, thus decreasing biodiversity on the site and eliminating important nesting habitat for salt marsh avian species.

7.1.2 Marine Fish and Essential Fish Habitat

Winter flounder larvae and young-of-the-year juveniles are known to thrive in tidal creeks and pools, like those on the site. Individuals in theses stages of their life cycle prefer the shallow, warmer, sandy-bottom estuarine habitats (NOAA 1999). Mummichogs, on the other hand, prefer vegetated high marsh habitat for depositing their eggs. Mummichog eggs are resistant to desiccation and have a delayed hatching period, allowing for laying and hatching to occur during the highest tides while exposed to air during incubation. Incubation and development in those protected areas of the marsh surface offer survival advantages over early growth in the strong currents and varying water levels of the tidal creeks and channels (Taylor et al. 1979).

Figure 19: Low and High Marsh Vegetation at Ninigret Pond Salt Marsh

Mummichogs also utilize the salt marsh habitat for foraging. Their tide-dependent feeding patterns bring them into the vegetated salt marsh habitat during the flood tide to forage before heading back out to deeper waters with the ebb tide (Weisberg et al. 1981). The intertidal benthos found in salt marsh habitat are crucial to the overall growth and development of the mummichog. Studies have shown that the growth rates of mummichogs that had restricted access to flooded salt marsh habitat and were only allowed to forage in subtidal channels were significantly lower than those allowed access to forage on the intertidal benthos within the salt marsh surface as well as in the subtidal channels (Weisberg and Lotrich 1982). Salt marsh surface and/or salt marsh tidal creeks and pools may provide benefits to the fish species utilizing those habitats, including a greater abundance and/or quality of food resources than in adjacent deeper open water environments, refuge from piscivorous predators, and/or reduced competition with other species that do not enter those areas with the tides (Allen et al. 1994). Over time, rising sea level will continue to drown out vegetation on the site, further destroying salt marsh habitat and negatively impacting the marine species that rely on it.

7.1.3 Wildlife Resources

Under Alternative 1 for this project, no dredged sediments will be placed on salt marsh areas to raise surface elevations. Existing decreased marsh surface elevations, coupled with rising sea level, would continue to degrade the vegetative communities on the site, resulting in the loss of the high marsh habitat critical to the survival of certain species including the saltmarsh sparrow, seaside sparrow, and willet.

The saltmarsh sparrow nests solely in high marsh habitat and forage in low marsh habitat, and thus are considered among the highest conservation priority in the region and listed as vulnerable on the International Union for Conservation of Nature (IUCN) Red List (Bird Life International 2012). Preliminary data indicates a 5 percent reduction in saltmarsh sparrow populations over the past 14 years (Correll et al. 2016). Currently, the Service is working closely with researchers to conduct a comprehensive saltmarsh sparrow assessment to evaluate the population status and ongoing threats to persistence (Service, personal communication, 2015). Saltmarsh sparrows are particularly susceptible to anthropogenic impacts such as SLR, coastal development, alterations in marsh tidal flows, and habitat degradation from invasions of non-native common reed (Field 2014). In the absence of intervention and restoration efforts, it is predicted that a reduction in the Long Island Sound saltmarsh sparrow population may drop below 100 individuals as soon as 2040 and reproduction in Long Island Sound will become impossible between 2045 and 2065 (Field 2016). Seaside sparrows and willets also nest in salt marsh habitat, making them vulnerable to salt marsh degradation and resulting habitat loss.

Under Alternative 1, sediment from the channel and Pond would be dredged and placed on subtidal or intertidal beach to the east of the breachway. The dredging is designed to prevent sloughing of the intertidal shoals where piping plover forage. Placement of the sand on the beach east of the breachway would be in intertidal areas and would not create additional suitable nesting habitat for piping plovers. However, plovers may be expected to use the sediments placed on the intertidal zone of the beach for foraging. Salt marshes would not receive the sandy sediments to raise elevations, and the marshes will continue to degrade, a condition that would have neutral effects for roseate terns and piping plovers, species that do not utilize vegetated marsh surfaces.

7.1.4 Water Quality

The decomposing marsh vegetation that is currently present within the project area is thought to be releasing nutrients and sediment into the salt pond, likely causing negative impacts to water quality. Without completing the restoration project, it is likely that continued negative impacts to water quality will persist as a result of the degrading marsh.

7.1.5 Tidal Flows

If the sediment dredging is delayed, the current trends will continue, further restricting tidal exchange. As a result of decreased exchange, water will be more likely to become trapped on the marsh interior, providing mosquito-breeding habitat. At the current rate of deposition, the channel needs to be dredged approximately every 4 years to maintain the restored eelgrass beds and provide healthy exchange within the marsh. The channel was most recently dredged in early 2012.

7.1.6 Sediment History and Handling

Under the No Action alternative, sediment dredging would be delayed until funding becomes available.

7.1.7 Cultural Resources

Potential for impact to cultural resources in the proposed project is primarily associated with ground- disturbing activities, i.e., dredging that would occur under the existing maintenance dredging permit. Prior coordination with the Rhode Island State Historic Preservation Office (SHPO) and the Narragansett Indian Tribe and THPO is documented in the 2002 EA for the Rhode Island South Coast Habitat Restoration Project (ACOE 2002) and resulted in a Programmatic Agreement between the U.S. Army Corps of Engineers New England District, the CRMC, and the Narragansett Indian Tribe (Appendix B).

7.1.8 Public Use and Recreation

Under Alternative 1, dredging may occur when funds are secured in the future. Until such time, it is expected that recreational access to the marsh and breachway will be further restricted by shoaling. The continued loss of salt marsh will reduce opportunities for bird watching of salt marsh specialist birds like salt marsh sharp-tailed sparrow and seaside sparrow.

Figure 20: Kayaks in Ninigret Pond

7.2 Alternative 2: Proposed Project – Restore Estuarine Conditions

Under Alternative 2, the Preferred Alternative, Action A, Action B and Action C are proposed as described in Section 6.3 and would be undertaken to enhance the estuarine conditions, restore salt marsh habitat and make the area more resilient to climate change impacts.

7.2.1 Salt Marsh Habitat

Under the Preferred Alternative, estuarine salt marsh restoration would occur. Sediment dredged from the sedimentation basins and relief channel would be spread over the site to help increase marsh surface elevations. This increase in elevation would decrease the impounded water areas in the marsh interior, restoring the salt marsh habitat and decreasing the potential mosquito-breeding habitat.

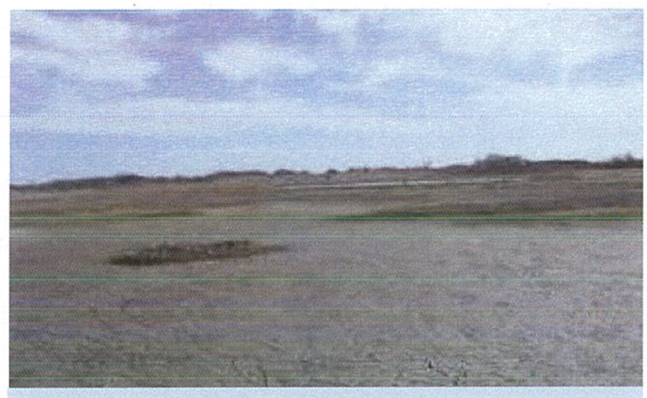

Figure 21: Dieback Area at Ninigret Pond Salt Marsh

Areas currently experiencing vegetation dieback would be restored to healthy low and high marsh communities. Following an elevation increase, high marsh species, including saltmeadow cordgrass, spike grass, and black rush would revegetate areas presently occupied by smooth cordgrass, a low marsh species that has moved into high marsh habitat due to elevation decrease and rising sea level. Those restored healthy vegetative communities have the potential to stabilize the ground and increase the capacity of the site to withstand storm tides. It is likely that this revegetation process would mimic that observed on the overwash fans (sand deposits) created by Hurricane Sandy in 2012. Within two growing seasons, bare areas that received significant depths of sand during Hurricane Sandy have been colonized by a variety of high marsh and shrub species.

7.2.2 Marine Fish and Essential Fish Habitat

The Preferred Alternative may have the potential to have an immediate effect on the on-site winter flounder population. Studies have shown that winter flounder, as well as other estuarine fish species, prefer areas with undisturbed bottom sediments and natural vegetation to areas where dredge spoil material had been deposited (NOAA 1999). TLD will occur on the marsh surface, thus avoiding any adverse impacts to spawning winter flounder. The existing fringe of marsh vegetation along the edges of the dieback or ponded areas will be preserved to act as a filter. The tidal creeks and pools will be avoided during the TLD process to preserve the natural habitat. The proposed activities will benefit the on-site winter flounder population by maintaining a healthy salt marsh habitat with shallow, sandy tidal creeks and pools. Additionally, protection from shoaling of the previously restored eelgrass community will benefit the population of winter flounder.

During the proposed restoration process, sandy-bottom channels, creeks and pools within the restoration area will be preserved to avoid impacts to the fish species that utilize the salt marsh habitat. Juvenile smooth dogfish inhabit areas like those on the site and would benefit from a healthy, restored salt marsh habitat for foraging.

Increases to marsh surface elevation will benefit the mummichog population utilizing the site. Restoring high marsh habitat is critical to the survival of this species, as they forage in vegetated salt marsh habitat (Weisberg et al. 1981) as well as deposit their eggs in vegetated high marsh areas during the highest spring tides to ensure protection during incubation and early development (Taylor et al. 1979). A healthy mummichog population is also important to the various bird species within the salt marsh that forage on these fish (i.e., terns, herons, egrets, etc.).

7.2.3 Wildlife Resources

Under the Preferred Alternative, high marsh habitat will be restored. High marsh habitat is particularly critical to tidal marsh obligate species during various stages of their life history. The saltmarsh sparrow nests in high marsh habitat such that loss in availability of this habitat would result in a decrease in nesting success and eventually lead to a decrease in populations in this area. Although there is some variability across the range of the species, nests are constructed just above the surface of the marsh and typically placed within high marsh grasses (Greenlaw and Rising 1994). Eggs and young chicks (less than five days old) displaced from the nest during flooding events are often unlikely to survive (Gjerdrum et al. 2008). Seaside sparrows and willets also construct ground nests in salt marsh habitat but utilize slightly different strategies. Increasing the high marsh ground elevation onsite will potentially aid in the protection of these nests from tidal floods, thus benefiting reproductive success. If there are small patches within the project area that contain suitable habitat, they will receive a very thin layer of material (if any), which will revegetate the following season and will likely be available for nesting (Service, personal communication, 2015).

In order to avoid impacts to the threatened and endangered avian species, dredging areas will not include intertidal habitat and construction will not occur during the times of year when these species are present. As previously mentioned, the impact area for sediment placement in the intertidal area east of the breachway (Action C) will be limited to the State-owned property, which is a short segment of the beach located adjacent to the TLD project site. Sand placement is not presumed to adversely affect piping plover breeding activity, as dredging and sand placement activities will be conducted within the intertidal zone below the mean high tide during the winter before the plovers return from their wintering range. Sanderlings may be present on the beach during the time of dredging and sand placement activities; however, because only a short segment of beach east of the breachway will be used for sand placement, the majority of the beach will be left undisturbed, providing sufficient sanderling habitat.

Invertebrate reproduction, generally occurring during spring, is not likely to be affected by the on-site sediment deposition, as species such as the fiddler crab and the long-clawed hermit crab release their eggs directly into the open water, and are thus not dependent on the salt marsh habitat for egg deposition. Of the invertebrate species known or presumed to inhabit the project site, none are federally or State-listed, and they are occurring in thriving populations within Ninigret Pond and other Rhode Island coastal ponds.

Mammal, amphibian, and reptile populations are rare or absent on the project site and are therefore not anticipated to be significantly impacted by the proposed project activities.

7.2.4 Water Quality

The water quality issues observed in Ninigret Pond may improve with increased tidal exchange, increased water depths and diversified aquatic habitat and ecosystems that will result from the proposed improvements. Marsh restoration will reduce the discharge of nutrients and sediment from the degrading vegetation, which is expected to positively impact water quality.

Temporary impairment of the water quality in Ninigret Pond may result from the sediment discharge operations, but are expected to be limited and temporary. Such impairments could include increases in turbidity levels; however, given the characteristics of the material, it is expected that turbidity levels will decrease quickly after deposition and that there will be no adverse or long-term impacts to the aquatic environment. Sediment spreading techniques have been recommended that will minimize turbidity increases to the maximum extent feasible to meet the project goals.

7.2.5 Tidal Flows

The dredging activities will result in increased passageway for aquatic species to their breeding and foraging grounds, therefore increasing productivity of recreational and commercial fisheries. Completion of the TLD project will reduce the potential for shallow ponding on the marsh, which could otherwise result in creation of mosquito-breeding habitat. It should be noted that no impacts are expected to the tidal prism within the Ninigret Pond complex as a result of dredging because dredging is not being executed at the tidal restriction point at the mouth of the breachway channel. In addition, the tidal creeks and pools will be avoided during the TLD process to preserve the natural habitat.

7.2.6 Sediment History and Handling

In order to mitigate negative impacts from the placement and spreading of the sediment across the proposed TLD areas, several mitigation measures will take place:

- load distributing "swamp mats" will be used on the marsh where equipment and machinery will be used to discharge and spread the sediment;
- small or low ground pressure equipment will be used and heavy equipment and machinery use will be avoided, particularly in areas with soft sediment;
- vehicular and equipment operations on the marsh will be monitored to allow for adjustment to avoid and limit rutting on the marsh;
- the height of the discharged material will be limited to reduce the potential for compression or subsidence due to the weight of the material;
- during sand placement, an adequate buffer zone will be maintained from the sandy-bottomed tidal creeks and pools within the project area identified as potential essential fish habitat to minimize impacts from increased turbidity or sedimentation. Any of these areas impacted by sediment placement will be restored immediately post-project completion; and
- restored areas will be planted or seeded with marsh grasses to enhance natural recolonization processes, increase stability and to reduce the potential for erosion.

The RIDEM determined that the material to be dredged is suitable for beach nourishment (ACOE 2002). The sediment arrived in the Charlestown Breachway as a result of natural deposition processes from ebb and flood tides. This is the same source of sediment that currently composes both East Beach and the Charlestown Town Beach.

The 2002 EA stated that dredging the sedimentation basins and completing the eelgrass bed restoration "will slightly alter the sediment composition of the ponds. It is anticipated that the sedimentation basins sediments will remain similar to the existing sediments, as the basins will be designated to capture the sandy material that moves into the ponds through the breachways…Sediment chemistry is not expected to be negatively affected by dredging operations because of the sandy nature of the sediment. Sandy material tends to settle rapidly following suspension and does not accumulate contaminants readily. Sediment composition in the [beach] disposal areas will not be impacted. The RIDEM (Water Quality Section) determined that the dredged material is suitable for beach nourishment at the selected disposal areas." While the sediment that is currently in the sedimentation basins is not the sediment that was initially tested, it is understood that the sediment is of the same general nature. Additionally, while the beach placement location on East Beach for the proposed project is not the same location as used for the existing EA as referenced above, the two beach environments are very similar and it is assumed that sediment that is suitable for beach nourishment on one would be suitable for the same on the other. Therefore, we expect the dredged material to be suitable for placement east of the breachway on the Charlestown Town Beach.

7.2.7 Cultural Resources

Potential for impact to cultural resources in the proposed project is primarily associated with ground- disturbing activities, i.e., dredging, which would also occur under the No Action alternative. Prior coordination with the Rhode Island SHPO and the Narragansett Indian Tribe and THPO is documented in the 2002 EA for the Rhode Island South Coast Habitat Restoration Project (ACOE 2002) and resulted in a Programmatic Agreement between the U.S. Army Corps of Engineers New England District, the CRMC, and the Narragansett Indian Tribe (Appendix B).

7.2.8 Public Use and Recreation

The proposed project is expected to have long-term positive impacts on public use of Ninigret Pond. Improvement and restoration of the estuarine and salt marsh habitat will improve the aesthetic as well as recreational fishing value of the site. An ancillary benefit will be improved recreational boating access to the Pond as a result of the dredging of the breachway areas.

It is not expected that construction of the proposed improvements will have a significant negative impact on recreational use of the site due to the low recreational use during the winter months when the improvements are proposed. See Section 7.2.9 for a discussion of Construction-Related effects. Permitted dredging windows have been established in consultation with the RIDEM, which operates the State boat ramp and camping area within the South Shore Management Area that will be used for the staging of equipment and the dredging operation, and are intended to avoid interference with peak-use periods.

The proposed project is expected to have a significant net benefit for recreational use of the Pond, including fishing, boating, wildlife observation, and environmental education.

7.2.9 Construction-Related Impacts

Construction operations will cause short-term, minor environmental effects such as short-duration increases in noise and air emissions due to construction equipment operation, temporary visual changes as construction is occurring, loss of immobile benthic organisms in the construction footprint, and temporary access restrictions for recreational use. However these effects are expected to be insignificant due to their limited duration and timing. It should be noted that the restoration area is only accessible by boat; therefore, significant impacts to recreation and public safety are expected to be minimal.

In order to minimize air quality effects during construction, construction activities will comply with applicable provisions of the Rhode Island Air Quality Control Regulations pertaining to dust, odors, construction noise, and motor vehicle emissions. Construction best management practices will also be followed to avoid spills, leaks, discharges of fuel or other vehicle fluids.

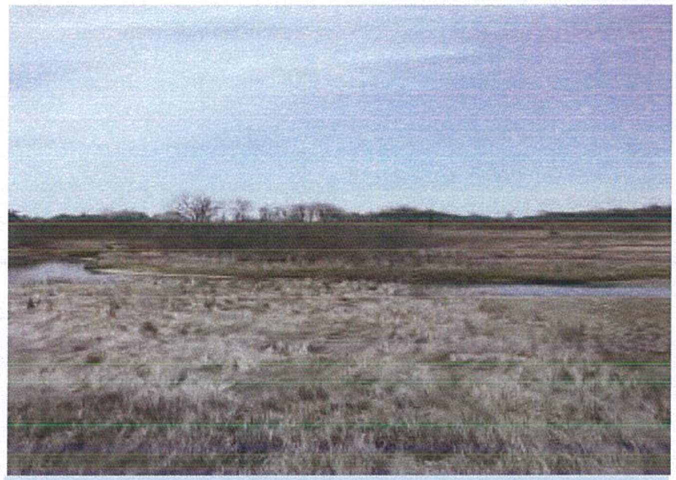
Figure 22: Healthy High Marsh Vegetation at Ninigret Pond Salt Marsh

Impacts to recreational uses will be mitigated by both the time of year for the project activities and through the use of adequate signage to inform visitors of the restricted areas and alternate locations for recreational activities.

Any impacts to water quality or suspension feeders resulting from increased turbidity will be limited to the time of sediment placement and should dissipate rapidly.

7.2.10 Indirect and Cumulative Impacts

As described in Sections 7.2.1 through 7.2.9, most effects associated with the Preferred Alternative are short-term and related to the construction period. Consequently, the only reasonably foreseeable indirect impacts (i.e., removed in time or place) associated with the Preferred Alternative are the beneficial impacts resulting in improvements in the salt marsh habitat and estuarine environment at Ninigret Pond.

Cumulative impacts are those resulting from a combination of past, present and foreseeable future actions with the incremental impact of the proposed project. Reasonably foreseeable actions include maintenance dredging of the breachway, and continued human activity in the watershed and Pond. Since the impacts associated with the proposed project are primarily beneficial, the potential for cumulative adverse impacts is insignificant.

Future maintenance dredging activity is anticipated to cause short-term, construction-related impacts, as described above. It is expected that human activity within the watershed draining to Ninigret Pond will continue to cause bacteria impairments within the Pond, unless actions as recommended in the TMDL are completed. Other actions within the area that may impact the project area in the future include increased erosion as a result of recreational boating wakes and potential habitat pollution as a result of human use (however, these impacts are not significant concerns at the present time.)

The source of the water quality impairment is not being addressed by this project; however, this project will improve salt marsh habitat in the project area, which is expected to have a positive impact on water quality. The project is also expected to have a near-term positive impact on public use and recreation within the Pond, as it will increase ease of access into and out of the Pond. It will also improve wildlife diversity and habitat which will likely increase the aesthetic value and wildlife viewing opportunities within the watershed as a whole. Restoring the high salt marsh habitat will provide crucial habitat for sensitive species (including migratory birds). By diversifying the marsh habitat, a more dynamic and valuable ecosystem will be created. Encouraging growth of the valuable high marsh species will also increase productivity within the marsh and reduce mosquito-breeding habitat.

The primary cumulative impact of the proposed project is the positive impact of improving salt marsh habitat and the estuarine environment, as well as providing future salt marsh habitat resiliency, and resiliency of the coastal barrier complex.

8 Consultation and Coordination

The following entities were consulted during the preparation of the restoration plan and in preparation of this EA:

- Salt Ponds Coalition
- State of Rhode Island Department of Environmental Management
  - Office of Water Resources
  - Division of Fish and Wildlife
  - Division of Marine Fisheries
- State of Rhode Island Coastal Resources Management Council
- State of Rhode Island State Historic Preservation Office
- Tribal Historic Preservation Office for Narragansett Tribe
- The Nature Conservancy, Rhode Island Chapter
- Town of Charlestown, GIS Department
- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- U.S. National Oceanic and Atmospheric Administration, National Marine Fisheries Service

9 Public Involvement

The project team is comprised of Federal and State government agencies, local government representatives, and non-governmental and community-based organizations, which have all provided extensive input throughout the project scoping and design phases. The project has undergone Federal and State permitting procedures, and the associated requisite public comment periods have provided ample opportunity for stakeholders to comment and provide feedback on the project's unavoidable short-term impacts.

Project team meetings have been held regularly since scoping of the project began in 2014, with the official project kickoff meeting held on March 5, 2015. A presentation describing the project was given at the Society for Wetland Scientists meeting in Providence, Rhode Island, on June 3, 2015. On July 9, 2015, the project was discussed at the Rhode Island General Permit team meeting by State and Federal permit authorities. On August 17, 2015, a presentation was given at the annual meeting of the Salt Ponds Coalition, the community-based watershed organization associated with the project area (also a project partner). The project has been the subject of articles in the local paper, the Westerly Sun (5/1/2015, 7/30/2015 and 10/8/2015). Additional outreach activities are planned for the duration of the construction and post-construction periods.

10. Lead Federal Agency Contact

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11. References

ACOE (2002). Final Environmental Assessment, Clean Water Act Section 404(b)(1) Evaluation and Finding of No Significant Impact: Rhode Island South Coast Habitat Restoration Project; Charlestown, South Kingstown, and Westerly, Rhode Island. June 2002. New England District of the Corps of Engineers.

Allen, E. A., P. E. Fell, M. A. Peck, J. A. Gieg, C. R. Guthke and M. D. Newkirk (1994). Gut Contents of Common Mummichogs, Fundulus heteroclitus L., in a Restored Impounded Marsh and in Natural Reference Marshes. Estuaries 17(2): 462–471.

Bromberg, K.D. and M.D. Bertness (2005). Reconstructing New England salt marsh losses using historical maps. Estuaries 28: 823-832.

Bird Life International (2012). Ammodramus caudacutus. The IUCN Red List of Threatened Species, Version 2014.3. www.iucnredlist.org.

Callender, Edward and E. Torello (2014). Aquatic Health of Ninigret Pond June through October 2013. Salt Ponds Coalition. Retrieved online on April 2, 2015 from http://www.saltpondscoalition.org/AHIMaps/Ninigret2013FW.jpg.

Center for Ecosystem Restoration (2015). Maidford Salt Marsh Restoration, Draft Project Description. Prepared for U. S. Fish and Wildlife Service.

Correll, M.D., W.A. Wiest, T.P. Hodgman, W.G. Shriver, C.S. Elphick, B.J. McGill, K.M. O'Brien and B.J. Olsen. (2016). Predictors of specialist avifaunal decline in coastal marshes. Conservation Biology.

Costanza R., O. Pérez-Maqueo, M.L. Martinez, P. Sutton and S.J. Anderson et al. (2008) The Value of Coastal Wetlands for Hurricane Protection. Ambio 37: 241–248.

Donnelly, J. and M. D. Bertness (2001) Rapid shoreward encroachment of salt marsh vegetation in response to sea-level rise. Proceedings of the National Academy of Science USA 98: 14218-14223.

DNREC (2013). DNREC's first beneficial-reuse marsh restoration project succeeds with thin-layer spray application. Retrieved online on May 14, 2015 from http://www.dnrec.delaware.gov/News/Pages/DNRECs-first-beneficial-reuse-marsh-restoration-project-succeeds-with-thin-layer-spray-application.aspx.

Ekberg, M.C., W. Ferguson and K. Raposa (2014). Results of the 1st Rhode Island Salt Marsh Assessment: Final Report.

Federal Register (2001). Presidential Documents: Executive Order 13186 of January 10, 2001: Responsibilities of Federal Agencies to Protect Migratory Birds. Federal Register. Vol. 66, No. 1, January 17, 2001. Retrieved online on April 2, 2015 from http://www.gpo.gov/fdsys/pkg/FR-2001-01-17/pdf/01-1387.pdf.

Ferguson, Wenley (2014). Historic and Current Status of Coastal Wetlands and Observations on SLR Impacts. Presentation to Beach Special Areas Management Plan Stakeholder Group Meeting, October 22, 2014.

Field, C.R. (2014) Can Tidal Marsh Birds Persist in the Face of Climate Change? University of Connecticut; Fall 2014 Narragansett Bay Journal. Retrieved online from http://www.nbep.org/journals/2014- nov/Special%20Edition_ Salt%20Marshes%20and%20Sea%20Level%20Rise.pdf.

Field, C.R. (2016). A threatened ecosystem in a human-dominated landscape: tidal marsh conservation in the face of sea-level rise. Ph.D. Dissertation. University of Connecticut, Storrs, CT.

Gjerdrum, C., K. Sullivan-Wiley, E. King, M.A. Rubega and C.S. Elphick. (2008). Egg and chick fates during tidal flooding of saltmarsh sharp-tailed sparrow nests. *The Condor* 110: 579–584.

Greenlaw, J. S. and J. D. Rising. 1994. Sharp-tailed Sparrow (*Ammodramus caudacutus*). In The Birds of North America. (A. Poole and F. Gill, Eds.). Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, D.C.

Haas, Meredith (2014). Tracking Salt Marshes: Impacts of Sea Level Rise. Retrieved online on May 10, 2015 from http://seagrant.noaa.gov/News/FeatureStories/TabId /268/ArtMID/715/ ArticleID/329/Tracking-Salt-Marshes-Impacts-of-Sea-Level-Rise.aspx.

Lake, John (2013). Young of the Year Survey of Selected Rhode Island Coastal Ponds and Embayments. Assessment of Recreationally Important Finfish Stocks in Rhode Island Coastal Ponds. Division of Fish and Wildlife, Rhode Island Department of Environmental Management. March 2013.

National Audubon Society (2013). *Ninigret Pond and Conservation Areas Important Bird Areas*. National Audubon Society. Retrieved online on May 16, 2015 from http://netapp.audubon.org/ IBA/Site/2473.

National Fish and Wildlife Foundation (NFWF) (2013). 2013 Hurricane Sandy Coastal Resiliency Competitive Grants Program RFP. Available at http://www.nfwf.org/hurricanesandy /Pages/2013rfp.aspx#.VVyq5PlViko.

Nightingale, Meghan (2014). A GIS Assessment of Salt Marsh Change in Rhode Island from 1981 to 2008. Wild & Scenic. 2014.

NOAA (1999). Winter Flounder, Pseudopleuronectes americanus, Life History and Habitat Characteristics. National Oceanographic and Atmospheric Administration Essential Fish Habitat Source Document. September 1999. Retrieved online on April 11, 2015 from http://www.nefsc.noaa.gov/nefsc/publications /tm/tm138/tm138.pdf.

NRCS (2002). Fact Sheets & Plant Guides. United States Department of Agriculture, Natural Resources Conservation Service Plant Database. Retrieved online on April 2, 2015 from http://plants.usda.gov/java/factSheet.

Paton, P. and C. Trocki. (1999). Avian use of three salt ponds in southern Rhode Island during Fall 1999. University of Rhode Island, Kingston, RI.

Portnoy, J.W. (1999). Salt marsh diking and restoration: Biogeochemical implications of altered wetland hydrology. Environ. Manage. 24:111-120.

Portnoy, J. W. and A.E. Giblin. (1997). Biogeochemical effects of seawater restoration to diked salt marshes. Ecological Applications. 7:1054-1063.

Public Law (1996). Magnuson-Stevens Fishery Conservation and Management Act; Public Law 94-265. As amended through October 11, 1996. Retrieved online on April 13, 2015 from http://www.nmfs.noaa.gov/sfa/magact/.

Rafferty, P., J. Castagna and D. Adamo (2011). Restoration Journal: Building partnerships to restore an urban marsh ecosystem at Gateway National Recreation Area. Park Science 27(3):1,3,34–41 Available at http://www.nature.nps.gov/ParkScience/archive/ PDF/Article_PDFs/Park Science27(3)Winter2010-2011_1_3_34-41_Rafferty_et_al_2760.pdf.

Raposa, K.B., R.L. Weber, M. Cole Ekberg and W. Ferguson (2015). Vegetation dynamics in Rhode Island salt marshes during a period of accelerating sea level rise and extreme sea level events. Estuaries and Coasts online publication; doi:10.1007/s12237-015-0018-4.

Raposa, K.B., M.L. Cole Ekberg, D.M. Burdick, N.T. Ernst and S.C. Adamowicz. (2016). Elevation change and the vulnerability of Rhode Island (USA) salt marshes to sea-level rise. Regional Environmental Change 16(5). DOI 10.1007/s10113-016-1020-5.

Redfield, A.C. (1972). Development of a New England salt marsh. Ecological Monographs 42: 201-237.

Rhode Island Sea Grant (2014). Retreating From the Rising Sea: Where Will Salt Marshes Go? University of Rhode Island, Graduate School of Oceanography. Retrieved online from http://seagrant.gso.uri.edu/blog/2014/10/16/salt-marshes-run-sea-level-rise-nowhere-go/.

Rhode Island Sea Grant (2015). Sea Level Impacts on Salt Marshes: Beach SAMP Updates. Rhode Island Sea Grant. Retrieved online on May 4, 2015 from http://seagrant.gso.uri.edu/ blog/2014/10/27/sea-level-impacts-salt-marshes-beach-samp-updates/.

RIDEM (2001). Fecal Coliform Total Maximum Daily Load for the Pettaquamscutt (Narrow) River Watershed, Rhode Island. Rhode Island Department of Environmental Management Office of Water Resources. December 2001. Retrieved online from http://www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/narrivdr.pdf..

RIDEM (2006). Total Maximum Daily Load Analysis for Green Hill Pond, Ninigret Pond, Factory Pond Stream and Teal Pond Stream, South Kingstown and Charlestown, Rhode Island: Final. Rhode Island Department of Environmental Management Office of Water Resources. February 2006. Retrieved online from http://www.epa.gov/waters/ tmdldocs/22684_ghptmdl.pdf.

RIDEM (2009). Water Quality Regulations. State of Rhode Island and Providence Plantations Department of Environmental Management Office of Water Resources. July 2006, amended May 2009. Retrieved online on April 7, 2015 from http://www.dem.ri.gov/ pubs/regs/regs/water/h20q09.pdf.

RIDEM (2015). Rhode Island State Wildlife Action Plan, 2015 Revision. Rhode Island Department of Environmental Management Division of Fish and Wildlife. Retrieved online on April 1, 2015 from http://www.dem.ri.gov/programs/bnatres/fishwild/swap15.htm.

Rountree, R. A. and K. W. Able (1996). Seasonal Abundance, Growth, and Foraging Habits of Juvenile Smooth Dogfish, Mustelus canis, in a New Jersey Estuary. Fishery Bulletin 94(3): 522–534.

Schwartz, M. L. (2013). Rhode Island South Shore Diamondback Terrapin Project Final Report 2013. Submitted to the U.S. Fish & Wildlife Service-Coastal Program, December 2013. Rhode Island Natural History Survey, Kingston, R.I.

Taylor, M. H., G. J. Leach, L. DiMichele, W. M. Levitan and W. F. Jacob (1979). Lunar Spawning Cycle in the Mummichog, *Fundulus heteroclitus (Pisces: Cyprinodontidae)*. American Society of Icthyologists and Herpetologists (ASIH). Copeia 1979(2):291–297). Retrieved online on May 5, 2015 from http://www.jstor.org/stable/1443417.

USEPA (2014). Pettaquamscutt Cove Salt Marsh, Environmental Conditions and Historical Ecological Change. U.S. Office of Research and Development, Environmental Protection Agency. June 2014.

U.S. Fish and Wildlife Service. 1994. Guidelines for managing recreational activities in piping plover breeding habitat on the US Atlantic coast to avoid take under Section 9 of the Endangered Species Act. U.S. Fish and Wildlife Service, Northeast Region.

U.S. Fish and Wildlife Service. 2008. Atlantic Coast Joint Venture, New England / Mid-Atlantic Coast Bird Conservation Region (BCR 30) Implementation Plan. www.acjv.org/BCR_30/ BCR30_June_23_2008_final.pdf.

U.S. Fish and Wildlife Service (2015), 1. Endangered Species. U.S. Fish and Wildlife Service. Retrieved online on April 1, 2015 from http://www.fws.gov/endangered/.

University of Rhode Island (URI). (2015). Restoration Methods: Salt Marshes. Retrieved online on May 10, 2015 from http://www.edc.uri.edu /restoration/html/tech_sci/restsalt.htm.

Watson, Elizabeth B. (2014). Vulnerability of Rhode Island Salt Marshes to Sea Level Rise and Poor Water Quality, Narragansett Bay Journal 28: 4-5.

Watson, E.B., A. J. Oczkowski, C. Wigand, A. R. Hanson, E. W. Davey, S. C. Crosby, R. L. Johnson and H. M. Andrews (2014). Nutrient enrichment and precipitation changes do not enhance resiliency of salt marshes to sea level rise in the Northeastern U.S., Climatic Change. doi:10.1007/s10584-014-1189-x.

Weisberg, S. B., R. Whalen and V. A. Lotrich (1981). Tidal and Diurnal Influence on Food Consumption of a Salt Marsh Killifish Fundulus heteroclitus. Marine Biology 1981(61):243–246.

Weisberg, S. B. and V. A. Lotrich (1982). The Importance of an Infrequently Flooded Intertidal Marsh Surface as an Energy Source for the Mummichog Fundulus heteroclitus: An Experimental Approach. Marine Biology 66: 307–31.

Woods Hole Group and Fuss & O'Neill (2015). Assessment and Recommendations for Ninigret Pond Salt Marsh Elevation Enhancement by Thin Layer Deposition of Dredged Sediment. Technical Memorandum. 35 pp.